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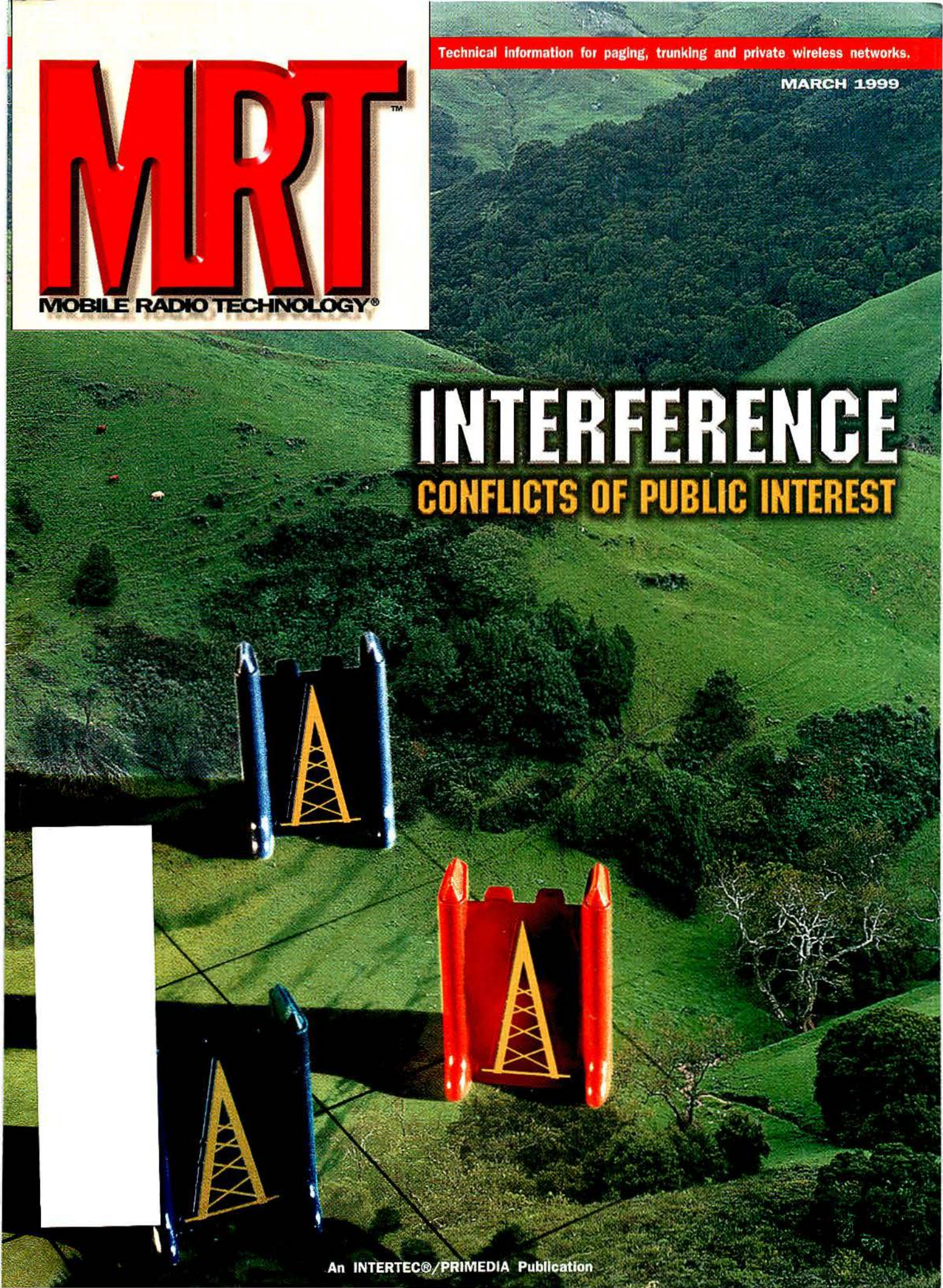
MARCH 1999

INTERFERENCE

CONFLICTS OF PUBLIC INTEREST



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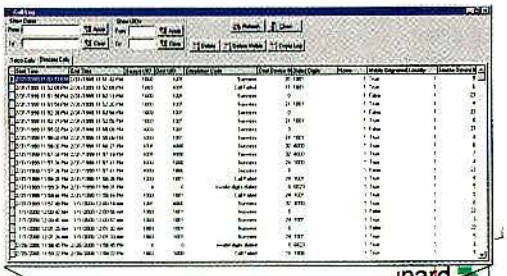

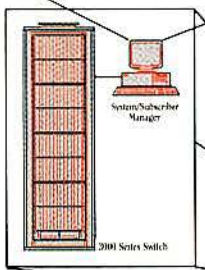

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MRT™
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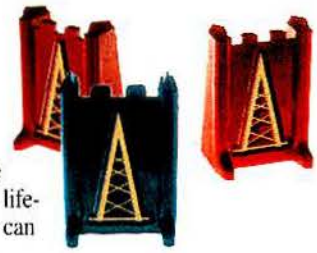
contents

March 1999

On the cover: Mapping the origins of interference harmful to public safety communications requires strategy and a methodical approach. The exercise may discover an unexpected EMI source—commercial mobile radio. See cover story on page 16. *Cover design by Scott Dolash, associate art director. Photography by D.A. Keckler.*

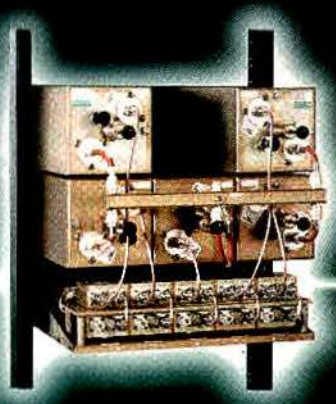
features



departments

Vol. 17, Issue 3. Mobile Radio Technology (ISSN 0745-7626) is published monthly by Intertec Publishing, 9800 Metcalf Ave., Overland Park, KS 66212-2215, and is mailed for free to qualified subscribers within the United States and Canada. Periodicals postage paid at Shawnee Mission, KS, and additional mailing offices. Canada Post Publications Mail (Canadian Distribution) Sales Agreement No. 0956309.
POSTMASTER: Send address changes to Mobile Radio Technology, P.O. Box 12960, Overland Park, KS 66282-2960.
SUBSCRIPTIONS: Non-qualified subscribers may subscribe at the following rates: United States and Canada: one-year: $35. Qualified and non-qualified subscribers in all other countries: one-year: $45 (surface mail); $105 (air mail). Subscription information: P.O. Box 12960, Overland Park, KS, 66282-2960.

BUILDING BLOCKS FOR 19" RACK SYSTEMS



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Rising above the noise

Getting attention for private mobile radio's spectrum and regulatory problems requires constant effort. Regulators come and go, including FCC commissioners, their advisers, and the commission managers and staff. (The same applies to members of Congress and their staffs.)

It helps to have part of the FCC organization dedicated to a particular service. This example could be argued, but if commercial mobile radio services (CMRS), including wireless telephone, paging and ESMR have been helped by auctions, then some of the thanks would go to the part of the FCC dedicated to running auctions. Moreover, another part of the FCC is dedicated to regulating CMRS.

Public safety radio communications has benefited from special attention on the part of Congress. Also, it has benefited from having a part of the FCC dedicated to its regulation, the Public Safety and Private Wireless Division within the Wireless Telecommunications Bureau. Look within that division, and you'll find people with specific responsibility for public safety radio regulation.

It is more difficult to find a part of the FCC devoted to private mobile radio (also known as "business and industrial" or "private wireless"), even though "private wireless" is part of the division's name. The division has a deputy chief for public safety, but not for private wireless. Sometimes people who answer the phone at the division even forget to say "private wireless."

If the needs of private wireless users are not on the minds of the lawmakers and the commissioners, it is unrealistic to expect to find division managers specifically assigned to serve those needs.

Check the main page of the Wireless Telecommunications Bureau (www.fcc.gov/wtb/) and you'll find a button for a public safety page (www.fcc.gov/wtb/publicsafety/), but you won't find one for private wireless. Private wireless *has* a page (www.fcc.gov/wtb/plmrs/plmrs.html), but you have to find it within the list of communications services.

The American Mobile Telecommunications Association has recommended that the FCC form a separate Business & Industrial Division, apart from a Consumer Division and a Public Safety Division. At least to the extent that a separate division would give business and industrial users the attention of a division chief, the idea has real merit. At present, business and industrial users don't even have a deputy chief assigned to them.

Among other trade associations, the Industrial Telecommunications Association keeps helping the voices of business and industrial users to rise above the noise of auctions and commercial service providers. At its urging, four U.S. senators and two U.S. representatives sent a letter to FCC Chairman William E. Kennard. The lawmakers reminded the chairman that legislation contained in the 1993 Omnibus Budget Reconciliation Act (OBRA) and the 1997 Balanced Budget Act (BBA) requires the FCC to use all available means other than auctions when it is faced with mutually exclusive private wireless applications. A pending FCC plan to auction private wireless spectrum is "inconsistent with the law and the intent of Congress," the letter reads.

The letter was signed by Senate Minority Leader Thomas A. Daschle (D-SD); Senate Commerce, Science and Transportation Committee members Slade Gordon (R-WA), Spencer Abraham (R-MI) and John B. Breaux (D-LA). Also signing was Rep. John D. Dingell (D-MI), the ranking minority member of the House Commerce Committee, and Rep. W.J. (Billy) Tauzin (R-LA), chairman of the Telecommunications, Trade and Consumer Protection Subcommittee of the House Commerce Committee. This kind of bipartisan support may deter the Wireless Telecommunications Bureau from going forward with private wireless spectrum auctions.

Instead, the lawmakers cited language from OBRA that requires the commission to use engineering solutions, negotiation, threshold qualifications, service regulations and other means to avoid mutual exclusivity in application and licensing proceedings. The ITA, several vendors and representatives of government agencies have been active in devising computer programs to resolve mutual exclusivity with engineering solutions. With encouragement from the lawmakers, the FCC might take another look at some of these alternatives.

The lawmakers reminded the FCC that Congress noticed that the commission had ignored the 1993 OBRA directive to avoid mutual exclusivity, so it emphasized in the 1997 BBA that the commission is "obligated to consider ways to avoid mutual exclusivity among applicants before conducting an auction."

Step back, and take another look. The FCC's managers aren't likely to be pleased that private wireless users have enlisted the aid of senators and representatives in an effort to derail their plans to auction private wireless spectrum, plans that apparently were nearing completion. At the same time, it is unfortunate that it is *necessary* for private wireless users to appeal to Congress to put the commission on the track that already was clearly laid out.

Maybe some of this conflict could be minimized if business and industrial users had better representation within the commission itself. At least one of the commissioners' advisers has expressed some interest in private wireless since attending ITA's October 1998 meeting. Getting their advisers' attention can be key to getting attention from the commissioners themselves. Even more important could be the assignment of a unit within the FCC staff to regulate and, one hopes, advocate private wireless interests.

* * *

Changes at Intertec

Our company name has reverted to Intertec Publishing Corporation. The name has a 30-year history, and it seemed to retain its cachet even during the 18 months we were known as PRIMEDIA Intertec. PRIMEDIA is still our parent company.

Larry Lannon advances to vice president of the reconfigured Communications Division, which is composed of nine magazines including *MRT*. He previously was group vice president for five of our magazines. Lannon replaces Cameron Bishop, who was president of the 28-magazine Communications and Entertainment Division. Bishop moves up to become president and chief executive officer. Bishop replaces Raymond Maloney, who becomes company chairman. Promoted to the new post of chief operating officer is Ron Wall, who previously was president of the 23-magazine Technology & Transportation Division.

Within our editorial group, Nikki Chandler moves up from associate editor to senior associate editor of *MRT*, *RF Design* and *Site Management & Technology*.

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NEXT MONTH – APRIL 1999

FEATURES AND NEWS: Fundamentals of fiber-optic communications, part II; IWCE Preview and Guide; interoperability; UHF trunking.

PLUS: Robert H. Schwaninger's "In the Public Interest;" Don Bishop's editorial; product focus: coaxial cable.

AND IN THE MONTHS TO COME: 800MHz trunking; solving propagation problems; lightning protection; power systems; microphones; microwave links; CAD/dispatch; fire radio and data.

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CORRESPONDENCE: Editorial correspondence should be addressed to P.O. Box 12960, Overland Park, KS 66282-2960. tel. 913-341-1300; fax: 913-967-7250; *mrt@intertec.com; www.mrtmag.com.*

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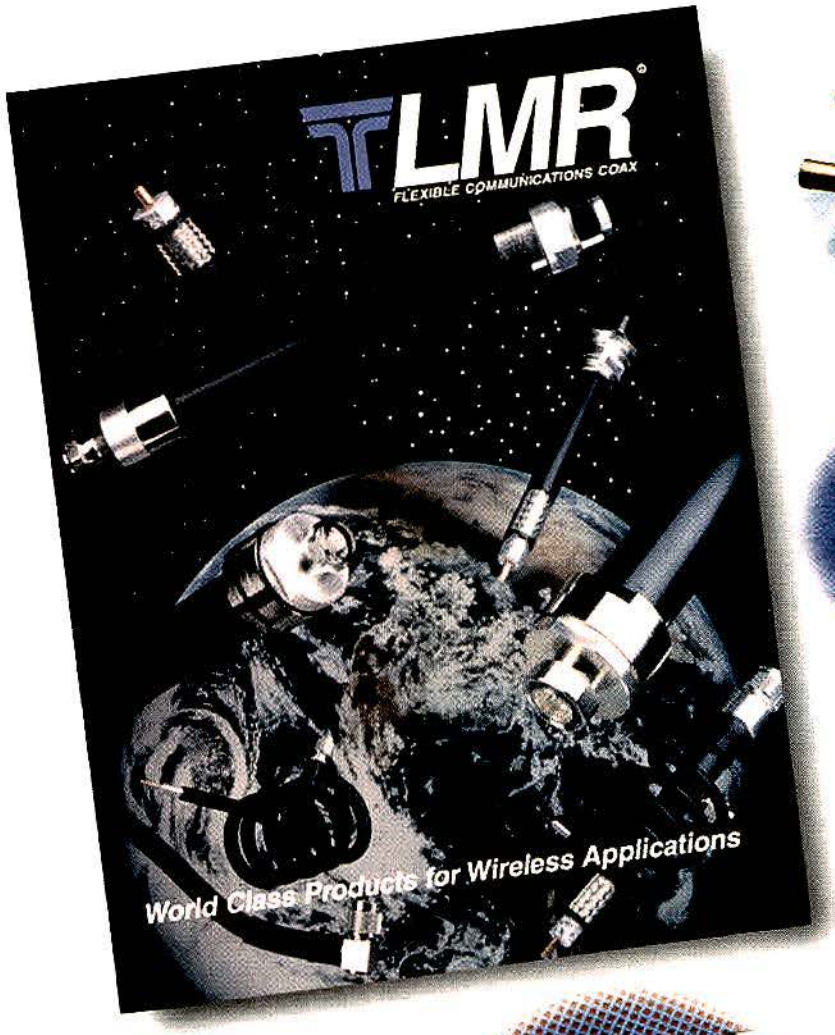

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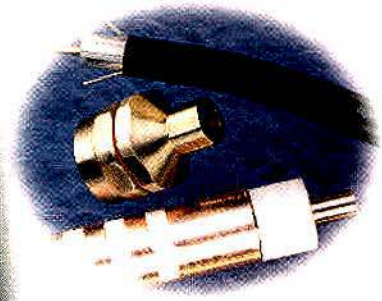

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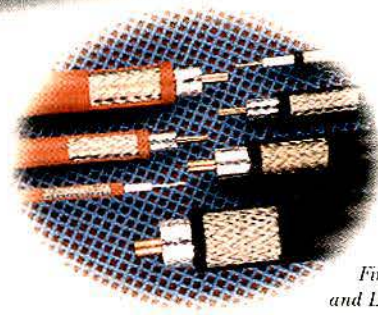

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Circle (16) on Fast Fact Card

calendar

March

8–9—Specialized Wireless Communications Management Conference, sponsored by AMTA, San Diego Hilton Beach and Tennis Resort, San Diego. Contact: 202-331-7773.

15–17—Association of Public-Safety Communications Officials—International (APCO) Western states regional meeting, San Diego Concourse, San Diego. Contact: 562-940-3362.

28–31—ENTELEC, sponsored by the Energy Telecommunications and Electrical Association, George R. Brown Convention Center, Houston. Contact: 281-357-8700.

April

28–30—International Wireless Communications Expo, co-sponsored by *Mobile Radio Technology*, Las Vegas Convention Center, Las Vegas. Contact: 800-288-8606.

May

10–13—Telecommunications Resellers Association Spring Conference and Exposition, San Diego Marriott. Contact: 202-835-9898.

June

1–3—Canadian Wireless, sponsored by the Canadian Wireless Telecommunications Association, Vancouver, Canada. Contact: 613-233-4888, ext. 102.

6–10—Supercomm, sponsored by the TIA and USTA, Georgia World Congress Center, Atlanta. Contact: 800-278-7372.

27–July 1—UTC Telecom '99, sponsored by UTC, Nashville, TN. Contact: 202-857-1881.

28–29—Leadership Conference & Annual Meeting, sponsored by AMTA, ANA Hotel, Washington, DC. Contact: 202-337-7773.

July

14–16—Communications Expo/Show of the Americas, Miami Beach Convention Center, Miami. Contact: Jackie Gonzales, 305-412-9000.

26–28—Telecommunications Resellers Association Summer Carrier Forum, Westin Harbor Castle, Toronto, Ontario Canada. Contact: 202-835-9898.

August

8–12—Association of Public-Safety Communications Officials—International (APCO) National Conference, Minneapolis. Contact: 904-322-2500.

September

23-25—Personal Communication Showcase, sponsored by Personal Communications Industry Association, New Orleans. Contact: 703-739-0300.

October

2–4—Wireless I.T. '99, sponsored by the Cellular Telecommunications Industry Association, Santa Clara, CA. Contact: 202-785-2842.

18–21—Annual APCO Canada Conference, sponsored by APCO, New Brunswick Canada. Contact: Jim Flanagan 888-CANAPCO.

November

10–14—Communications Marketing Conference, sponsored by the Communications Marketing Association, Harvey Hotel, Dallas. Contact: Jack Armstrong, 410-628-9300.

15–16—AMTEX, sponsored by the American Mobile Telecommunications Association, Hilton, Walt Disney World Village, Lake Buena Vista, FL. Contact: 202-331-7773.

15–16—Fourth International Congress on Commerical Trunked Radio, sponsored by the International Mobile Telecommunications Association, Hilton, Walt Disney World Village, Lake Buena Vista, FL. Contact: 202-331-7773.

17–19—TelecomLatina, co-sponsored by *Mobile Radio Technology*, Miami Beach Convention Center, Miami. Contact: 800-288-8606.

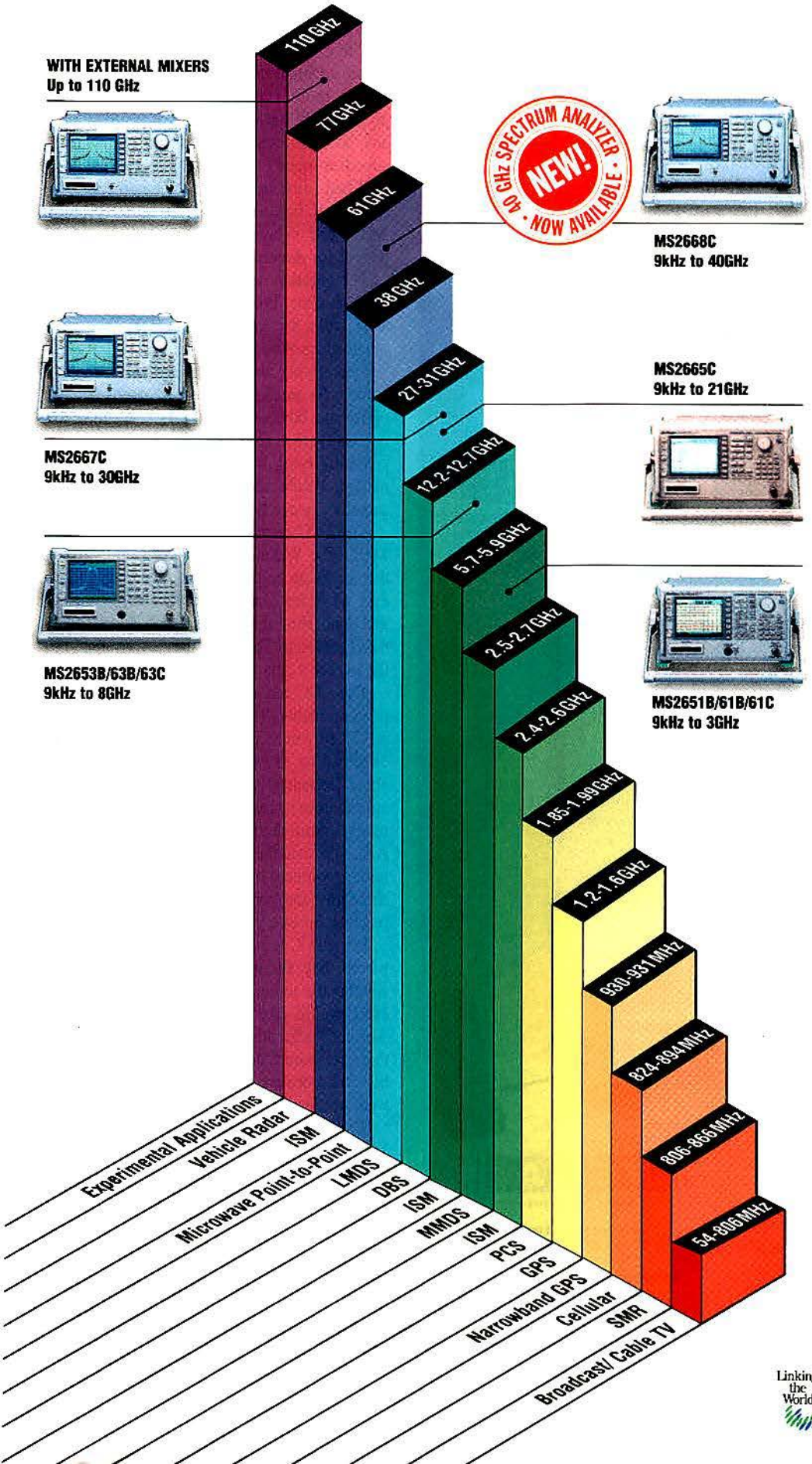
19—Radio Club of America Communications Symposium, 91st Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Gerri Hopkins, 732-842-5070.

February

28–March 1—Wireless, sponsored by the Cellular Telecommunications Industry Association, Ernest Morial Convention Center, New Orleans. Contact: 202-785-0081.

editorial index

Full Spectrum. Fully Analyzed.



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Circle (17) on Fast Fact Card

It came from Washington

The FCC has taken up another cause—one that is valiant and noble—but a waste of precious time. FCC Chairman William Kennard has released a study and has conducted a forum on the impact of advertising practices on minority-owned and minority-formatted broadcast stations. The FCC said that the study revealed a tale of two systems: Broadcasters who are serving the minority community earn less per listener. The study recommends adopting a Code of Conduct to oppose unfair ad placement and payment, to encourage diversity in hiring and training and to enforce laws against unfair business practices.

The cause for civil rights is a legitimate cause, an important cause, but the FCC has enough to do. It doesn't interfere with actual programming yet (Howard Stern is still on the air), so why does it think it can tell *who* to advertise *where*?

When I first saw this study, I assumed that the Small Business Administration or the ACLU had orchestrated it. It would be a great project for *Advertising Age* magazine.

The question is: Why is the *FCC* worrying about minority broadcasters getting a fair rap? Well, under Section 257 of the 1996 Telecommunications Act, the commission is *justified* "in identifying and eliminating market entry barriers for small businesses." It seems fatally optimistic, however, that the FCC is going to magically take out any barriers to small entrepreneurs trying to enter the broadcast radio market. Would adopting a Code of Conduct actually *remove* barriers?

The FCC is more like the Blob than like Merlin the Wizard. A slimy, shapeless goop that sucks up responsibilities and projects; it eats whatever Congress (and complaintants and applicants) throw at it, and it doesn't spit them back out. The more that is thrown at it, the bigger it gets.

The FCC has a backlog of about 50,000 pending matters (see "In the Public Interest," p. 12), so why is it spending time and money on dictating to broadcast advertisers? What about licensing issues, technological issues, enforcement issues ...? Last July, Senate Commerce Committee Chairman John McCain (R–AZ) said that the FCC was running a "do-nothing wireless bureau." He was the one who demanded the compilation of all the matters pending for one year or longer.

Is the FCC is going to dictate to advertisers where they should advertise, regardless of whether the audience is buying their products? *MRT* would like to have Honda, Sony or Absolut Vodka advertise in the magazine, but those companies do not sell specifically to mobile radio dealers, so they probably wouldn't want to advertise in *MRT*.

The latest news coming from the FCC, ideally, would not be about a study and forum on where companies should advertise. It should be that the FCC has resolved the Goodman/Chan specialized mobile radio case, or that it has repealed mandatory resale laws in the paging and wireless carrier industry or that it is taking care of antenna-siting moratoria and taxes.

Sadly, however, that is not the case. The FCC continues to engulf everything in its path.

—Nikki Chandler

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Circle (19) on Fast Fact Card

The waiting game

By Robert H. Schwaninger Jr.

It's that time of year when we are all thinking of spring. It isn't here yet, but we're thinking about it, nevertheless. Green leaves, budding flowers—a time of hope. If you're like me, you have already started thinking about the IWCE show April 28–30 in Las Vegas. I think about the show because it seems to kick off the warm season for me—the growing season. What I'm growing is impatient.

Is it just me, or do you feel as though you've been placed "on hold" by the FCC? *"All our lines are busy. Please stay on hold for our next-available political agenda. Your petition is important to us...."* This of course is followed by a Muzak arrangement of Tony Orlando singing the refarming order song, "Tie a long red tape around the F-C-C...."

A few months back, a member of my office got a letter from the FCC that began "In response to your letter of April 4, 1990...." Huh? He was amused and mystified by this correspondence regarding a "dead-letter petition" that has obviously been entangled in a sorting machine at the agency for eight years. This would be far more amusing if it were an anomaly.

The truth is that the agency is sitting on a stack of pending petitions, mutually exclusive applications and complaints—a plethora of work that could keep a team of dedicated government workers cashing COLA raises for the next five years. The Wireless Telecommunications Bureau alone faces an estimated 50,000 pending matters, rotting into mulch beneath and around bureaucratic desks. Why?

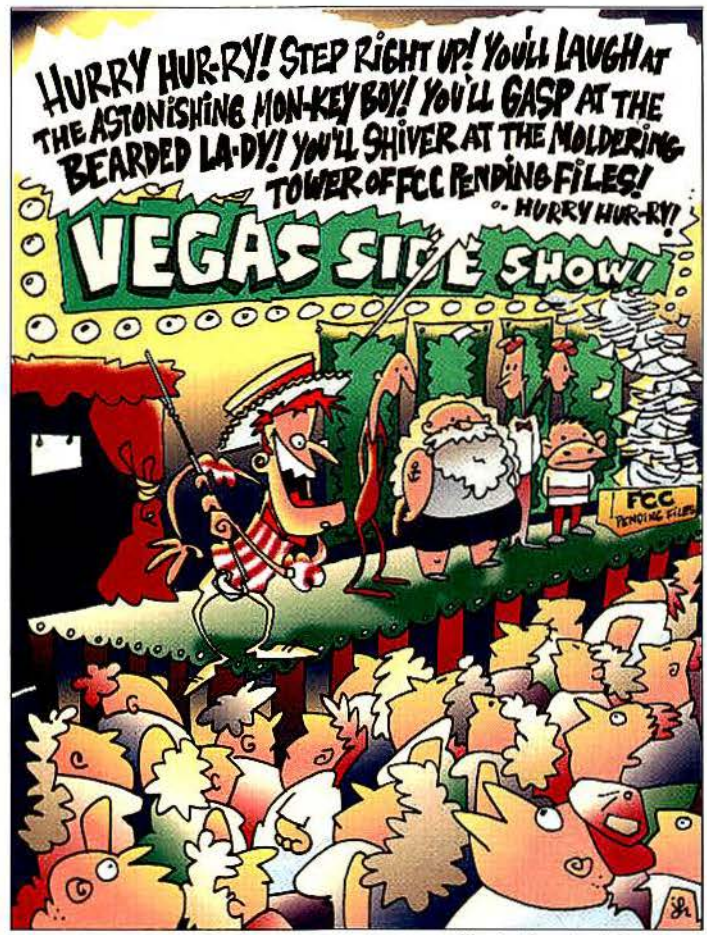

Illustration by John Hayes

Do I gotta?

With few exceptions, the FCC has no set time period for responding to a petition or to an application. "So, if you file something on Thursday, it may not get a response until the following Monday?" you ask. Ha-ha! *That's* a good one! What I mean is that if you had filed it during the Roosevelt administration, it might not get a response until Saddam Hussein gets his Nobel Peace Prize.

Now, we could pound the table and grouse about the fact that only government has no deadlines, while the rest of the world owns a watch, but *that* isn't going to change. (Not as long as the government can manipulate its performance numbers by pointing to its claimed efficiency in processing routine work, while covering up its abysmal record on the harder stuff.)

The agency's penchant for procrastination has always caused me, as an attorney (you can tell by my scales), problems. Clients are forever calling and asking "What ever happened to ...?" We explain that after a petition has been filed, the FCC moves at the same pace as continental drift, and there is little (short of changing your company name to "AT&T") that will get the darn thing off center. Then the client ends the conversation with "Well, see what you can do about it."

The fact is, unless you are willing to be the pest-from-hell (and not always even then), the FCC is going to use its manpower in the way that *it* deems proper for *its* needs. What the agency deems appropriate is furthering pet projects, such as auctions, universal licensing systems and HDTV. What the agency *doesn't* deem as important are the problems of mere licensees.

So, even if well-meaning desk workers and branch chiefs understand the desire for resolution of your particular matter, their time is used up forwarding some grand vision of a handful of politically appointed folks who wouldn't know a yagi from yogurt. And the law lets this happen because there is no remedy for those of us left waiting for years to get a response to a petition. The truth is, they don't *gotta* do *nothin'*.

When it gets ugly

The situation goes from farce to tragedy when the agency fails to act on pending matters that directly affect the ability of businesses to plan, grow and survive. One paging company in Southern California was left in limbo for five years, awaiting the FCC's decision that its 900MHz paging applications were eligible for grant. This small business had already begun building out a system. Then the FCC froze the processing of competing 900MHZ paging licenses—for years—while the industry waited for the agency to sort out its little application snafu. The company nearly failed while waiting.

Perhaps the worst example is the collection of matters pending about SMR licenses. Off the top of my head, I know that the agency has petitions filed before it that challenge the licensing of more than 30,000 channels across the nation. Although finder's preference matters are no longer accepted, existing ones are still pending. Petitions that have sat around without action for more than five years are occupying some pigeonhole in Gettysburg, PA. Having prepared some of these petitions, I can tell you that if and when the agency gets around to deciding these matters, the status of SMR licensing will change.

Schwaninger, *MRT*'s regulatory consultant, is the principal in the law firm of Schwaninger & Associates, Washington. He is a member of the Radio Club of America.

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For example, the agency has a series of petitions filed by more than a half-dozen operators in California that challenge a 175-channel ESMR footprint across the state. These petitions were filed in 1994 and clearly show that the applicant failed to take into account existing licensees when the applications were filed. Maybe the fact that the applications lacked any engineering exhibits is a clue as to how the problem arose.

What isn't so clear is why the FCC hasn't acted on the petitions, dismissed the applications and bombed any later application that relied on the original, bogus ESMR filing. Instead, the FCC tried to supply its own engineering to fix the problem, which begs the question, "Since when does the agency supply free engineering services to applicants?" The matter is still pending before the FCC.

The FCC has long had the character of an ostrich. When the going gets tough, it buries its head in the sand.

Since those petitions were filed, the FCC has pushed through a rulemaking on geographic licensing of SMR systems, held an auction, gone to court over its methods and issued wide-area licenses to auction winners. So why didn't it pause long enough to clean up its licensing, including this pending matter, prior to going to auction?

Struthio camelus gubernmentum

The FCC has long had the character of an ostrich. When the going gets tough, it buries its head in the sand. There are no tough choices, only those that are out-of-sight above ground level. Because, if you pull your head out, you might discover that *you're* the problem.

One matter before the agency is a long-standing dispute between a couple of common carriers. The first one complained to the FCC that it was receiving harmful interference. The second one noted that the only reason carrier number one was getting interference was because it was operating its station illegally. The FCC lawyer in charge of this one called both parties and asked them to settle the matter. Problem: How do private parties "settle" a violation of the FCC rules? It's like asking the victim to "settle" with the mugger. The settlement didn't occur, so the matter has been left pending for more than five years.

The FCC files are filled with these kinds of problems. As the agency auctions off spectrum, these problems are magnified. One takes no comfort in the agency's "buyer beware" admonition to bidders, referring to the hidden sea of problems that can greatly affect the value of spectrum. Nor is the agency doing anything about auction participants who leverage bad licenses to gain an advantage in auctions, knowing that the records make the spectrum appear more encumbered than it truly is.

What can we do?

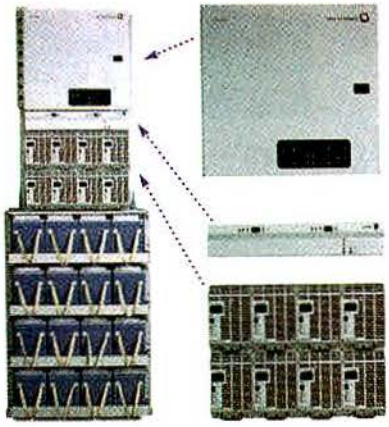
Because this problem is as pervasive as sore throats at a hog-calling contest, here's what I want us to do about it. I want you to bring to the IWCE show a copy of every petition, application, motion and complaint that you've got that has been pending before the FCC for more than two years. Please make sure of the following:

- ❑ First, the matter still has to be "alive" before the FCC, awaiting some darn decision to move it along.
- ❑ Second, the documents have to be dated *before* 1997.
- ❑ Third, bring *copies*. Don't give up your originals because you aren't getting them back.

Drop off all your "entries" at the *MRT* [Intertec Publishing] booth on the exhibition floor. The person who brings the oldest outstanding matter will receive a prize (to be announced after *MRT* figures out what it can afford to give the poor sucker). *All entrants* will have the copies of their matter placed before Congress with a request, to be prepared by yours truly, asking that the Senate Commerce Committee direct the FCC to forward the matters to resolution. The oldest, most interesting or just plain *bizarre* case will be featured in a future column. My clients are eligible, but in the spirit of fair play, I won't help them remember their stuff (particularly because I can't remember what I wrote two weeks ago).

So, dust off your files, and get that old application that was prepared by Mark Fowler before he became chairman. Grab that pleading that's addressed to Private Radio Bureau Chief McKinney. Take a walk down memory lane with the likes of FCC officials Robert Foosner, Morgan O'Brien and Robert McNamara before there was a Nextel. Unearth that old complaint addressed to the Field Operations Bureau at one of its closed regional offices. See why your father passed on to you a yellowing stack of FCC forms 10 years ago, saying, "They're all we've saved. All we have left."

If we can't get service, together, maybe we can make a point. ■



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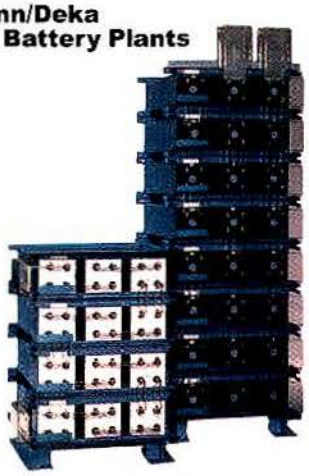

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IM/EMI ISSUES

A CONFLICT OF PUBLIC INTEREST

Conflicts between 800MHz commercial mobile radio service and public safety communications have cropped up across the country. When does nuisance interference become harmful--life threatening--interference, and how can it be identified and solved?

By Joe Kuran

Police, fire and emergency medical services agencies depend on radio communications to protect people and property. Any type of interference to the operation of dedicated public safety frequencies diminishes an agency's ability to provide service, and it endangers the public. A situation we encountered in Northwest Oregon in 1998 demonstrated that commercial mobile radio services (CMRS), particularly enhanced specialized mobile radio (EMSR), through frequency use, site placement and output power, can seriously interfere with nearby public service communications.

Operational overview

Washington County includes the Tualatin River Valley and mountainous terrain on the western outskirts of the Portland metropolitan area in Northwest Oregon. The Washington County Consolidated Communications Agency (WCCCA) provides emergency dispatch radio communications for 21 public safety agencies in Washington County, as shown in Figure 1, below right. Washington County covers 842 square miles, with a population of 350,000. In 1991, voters approved a levy to construct a new 9-1-1 system that included a Motorola Smartnet trunking system.

Because of limited resources and limited available frequencies, a 10-channel trunked simulcast system was chosen. This system would give WCCCA maximum area coverage with a minimum number of frequencies. WCCCA constructed four simulcast sites with 10 frequencies each. Given the large area that had to be covered, four sites were strategically chosen and, as with traditional radio systems, the repeater sites were installed on mountaintops for maximum coverage. (See Figure 2 on page 18.) With this design, WCCCA can provide radio service for more than 2,000 users, covering about 63% of Washington County. This system gives WCCCA good mobile coverage and fair portable coverage on the valley floor, which contains the bulk of the population.

The one big limitation of WCCCA's system is good portable radio coverage inside certain buildings. To overcome this building penetration problem, WCCCA has installed bi-directional amplifiers in many buildings, such as the county jail. Some high-traffic buildings, such as the Washington Square shopping mall, had to be excluded from in-building coverage. Due to the extreme expense and difficulty in establishing who would be the responsible party, no bi-directional amplifiers were ever installed, so presently there is marginal public safety coverage in this commercial area.

Defining interference

There are several types of radio interference. *Co-channel interference* occurs between similar frequency channels used in the same geographic area. *Adjacent-channel interference* can be caused by a transmitter operating on a channel bordering either side of the channel in question. The transmitter sidebands mix with the carrier being received on the desired channel, creating noise or "splatter." Interference can also be caused by electromagnetic interruptions. *Harmful*

Kuran is technical systems manager for the Washington County Consolidated Communications Agency, Beaverton, OR. He is the frequency coordinator for the state of Oregon for the Association of Public-Safety Communications Officials—International.

interference has a specific connotation. As defined by the *Communications Standard Dictionary*, it is

> "...any *emission, radiation* or *induction* that endangers the functioning or seriously degrades obstructs, or repeatedly interrupts a *communication service*, such as a *radio navigation service*, a *search and rescue communications*, or a *weather service*. It is assumed that these services are operating in accordance with approved standards, regulations and procedures. Harmful interference causes *circuit outages* and *message losses*, as opposed to interference that is merely a nuisance or annoyance that can be overcome by appropriate measures. In order to be harmful interference, it must seriously degrade the performance of the *communications, radar*, or other *electrical* or *electronic system*."

Interference with public safety communications from properly operated commercial radio services has traditionally not been a problem in our operating area. As with our own system, land mobile repeater sites were located on mountaintops and end users were on the valley floor. When the 800MHz (824MHz–849MHz and 869MHz–894MHz bands) cellular service was introduced, with cell sites located on the valley floor, there were still few problems. Public safety 800MHz bands (806MHz–821MHz and 851MHz–866MHz) enjoyed adequate separation from cellular,

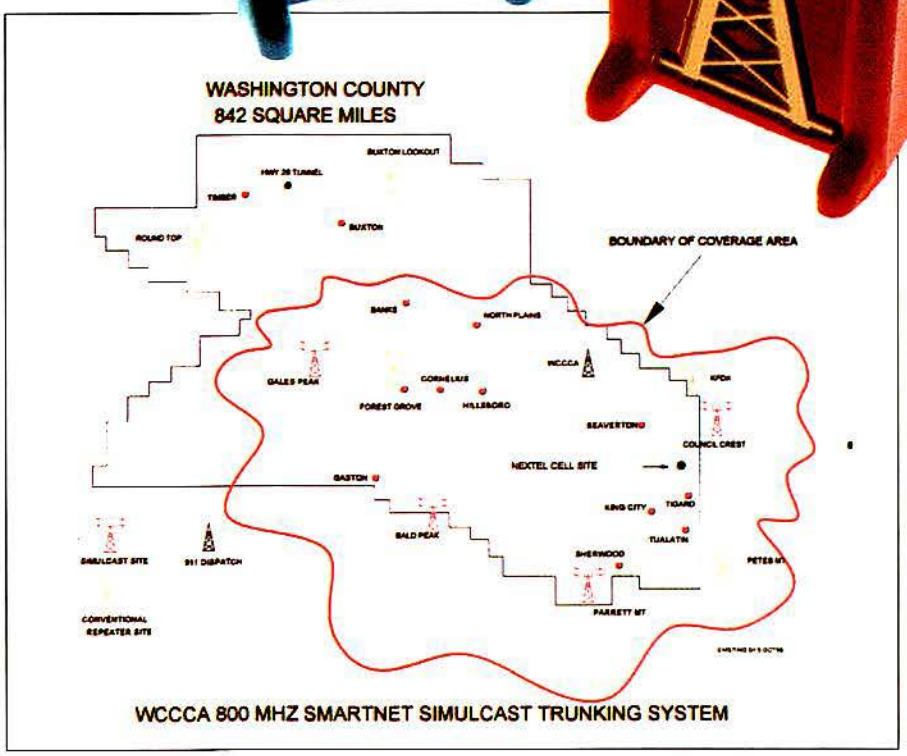


Figure 1. This map of Washington County, OR, shows the general area of WCCCA's 800MHz service area. Using simulcast trunking, WCCCA covers a large area, using only 10 frequencies, and supports more than 2,000 users. All simulcast sites are on mountaintops for maximum coverage. A Nextel site (center) is on the valley floor.

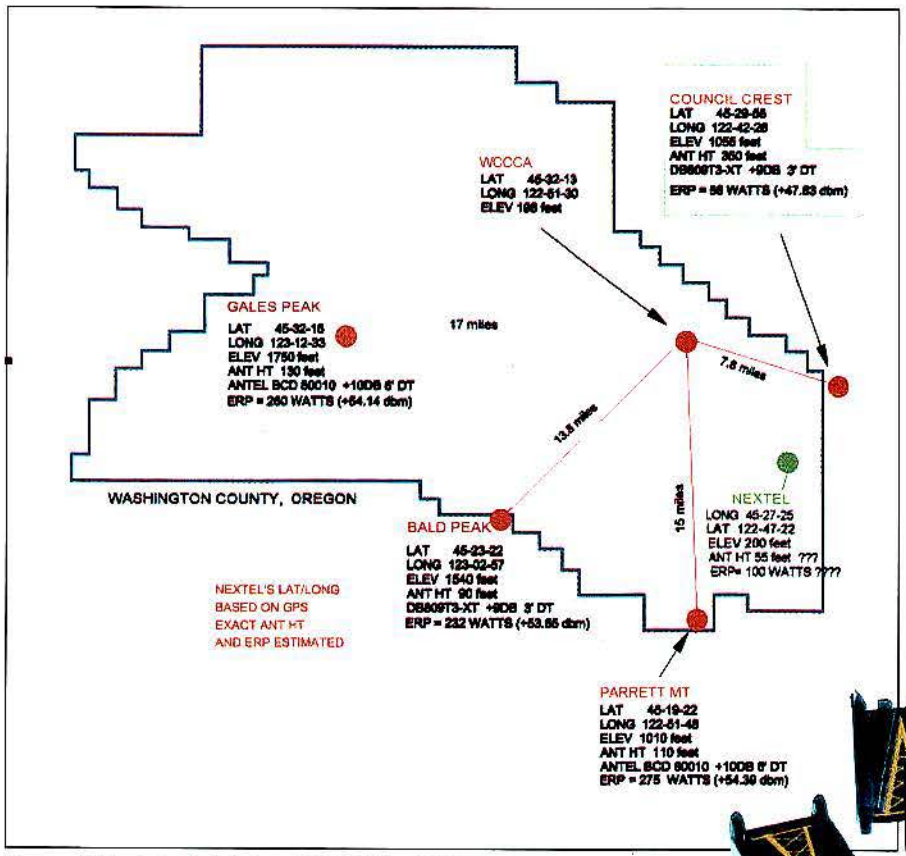
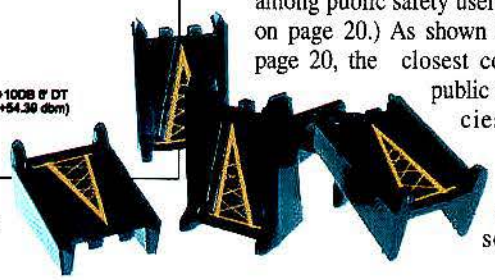


Figure 2. Technical details of WCCCA's 800MHz repeater sites. Elevation comparisons are made between the WCCCA sites and the Nextel site under study.

which was also grouped in one bandpass, while public safety was grouped in another. This situation changed with the introduction of 800MHz ESMR into the valley.

Enter ESMR

The FCC band plan for the 1998 800MHz SMR auctions divided the band into three pools: a public safety, industrial/land transportation and business pool, a general category pool, and an SMR category pool. The pools are interspersed from 810.25MHz to 816MHz and from 855.25MHz to 861MHz. In the FCC's 800MHz auction that closed in December 1997, McLean, VA–based Nextel Communications was the high bidder for the Portland-Salem, OR, economic area, which at that time encompassed an estimated 2,310,060 pops. The operator began service in 1998, placing 800MHz (806MHz–821MHz and 851MHz–866MHz bands) cell sites on the valley floor, among public safety users. (See Figure 3 on page 20.) As shown in Figure 4 on page 20, the closest commercial and public safety frequencies come to each other is four 25kHz channels away, so there is no



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SS-25	20	25	2 7/8 x 7 x 9 3/8	4.2
SS-30	25	30	3 3/4 x 7 x 9 5/8	5
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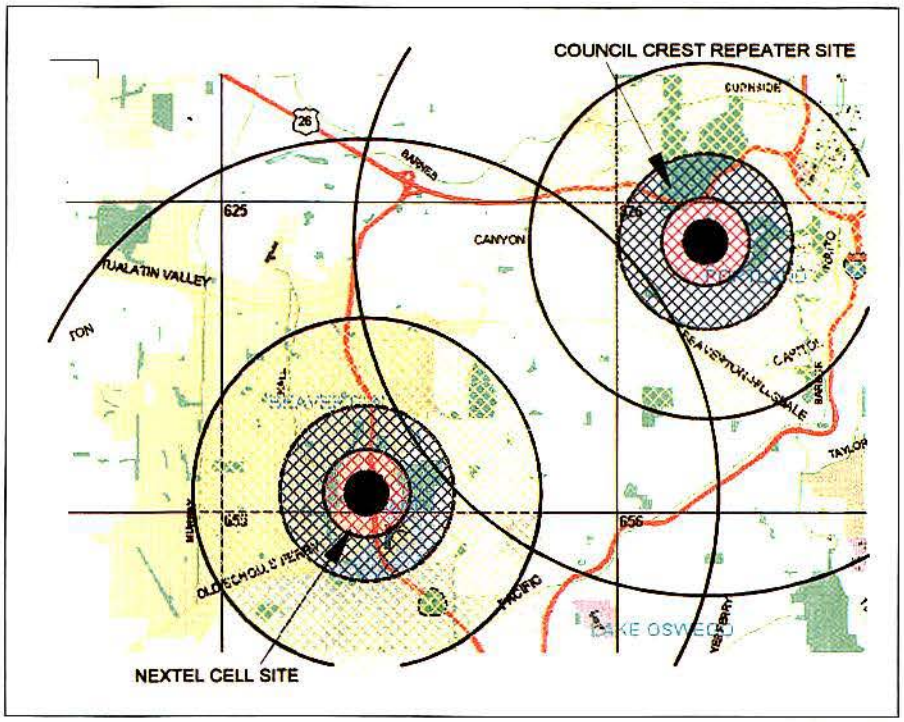
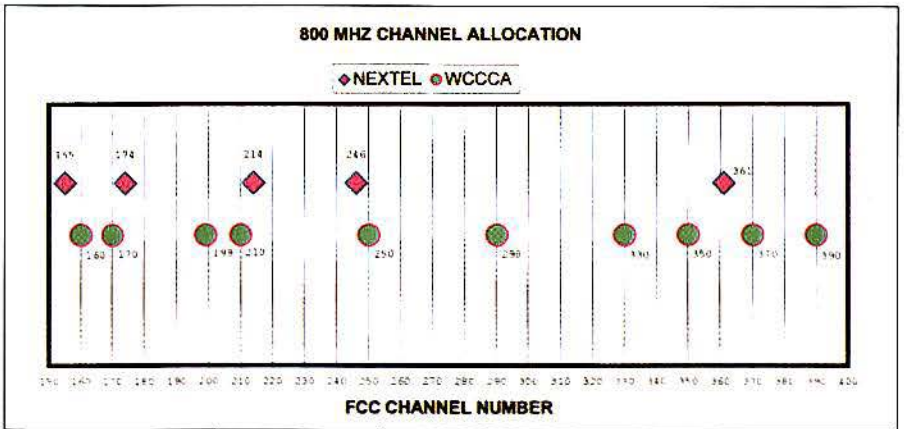


Figure 3. The relationship between Nextel and WCCCA's closest 800MHz trunking site. The color bands show the relative field strength from the two sites. WCCCA's Council Crest site is located on a mountaintop to provide wide-area coverage. Nextel's site is on the valley floor, in the heart of WCCCA's core radio service coverage area.



FCC CHANNEL NUMBER	FREQUENCY (MHz)	CHANNEL USER	SPACING TO CLOSEST FREQUENCY (kHz)
155	854.8625	NEXTEL CH. 309	
160	854.9875	WCCCA CH. 10	100
170	855.2375	WCCCA CH. 9	75
174	855.3375	NEXTEL CH. 347	
199	855.9625	WCCCA CH. 8	600
210	856.2375	WCCCA CH. 7	75
214	856.3375	NEXTEL CH. 427	
246	857.1375	NEXTEL CH. 491	
250	857.2375	WCCCA CH. 6	75
290	858.2375	WCCCA CH. 5	1075
330	859.2375	WCCCA CH. 4	750
350	859.7375	WCCCA CH. 3	250
361	860.0125	NEXTEL CH. 721	
370	860.2375	WCCCA CH. 2	200
390	860.7375	WCCCA CH. 1	700

Figure 4. The relationship between the commercial frequencies and Washington County's 800MHz frequencies. The closest commercial frequency is at least four 25kHz channels away. Therefore, the interference is not adjacent-channel interference.

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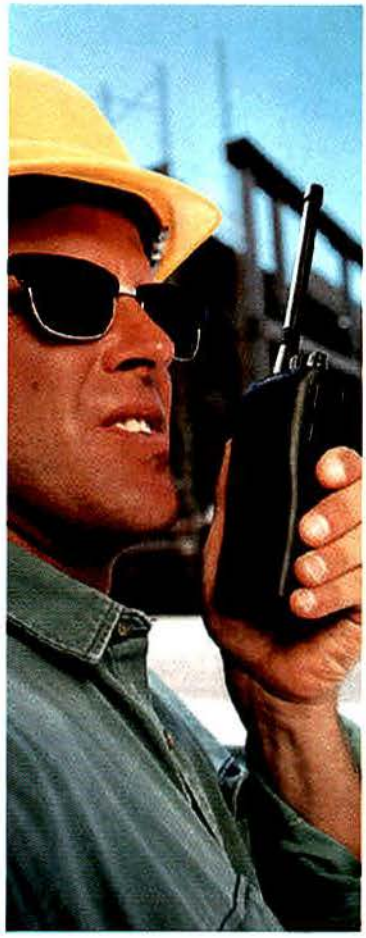

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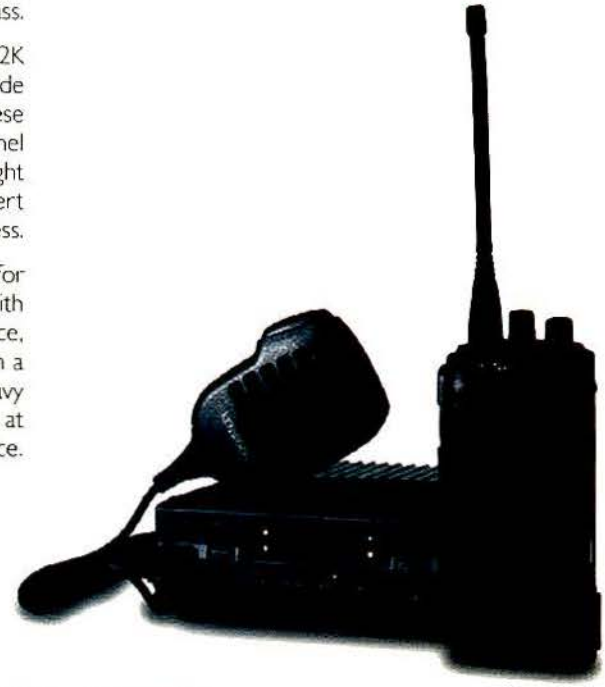

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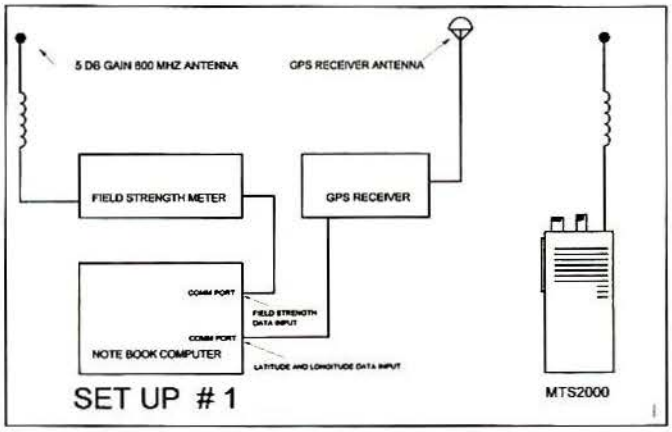

Figure 5. Field strength meter test measurement setup. A Z-Technology model R-505 meter was used. The GPS receiver provides location information to the notebook computer, an NEC Versa 5080X, running STI-9400 Mobile Signal Analysis System software from Survey Technologies.

possibility of adjacent-channel interference. However, because the band plan for 800MHz intermixes commercial frequencies with public safety frequencies, there is no chance of any group bandpass filters, as in the case of cellular. A problem was brewing, as we soon found out.

When we get behind closed doors—only

The first incident to bring an interference issue to the attention of WCCCA was a radio service complaint from one of the fire departments. This fire station, one of 33 in the county, is designated Fire Station 253. It serves one of the busiest areas of the county because it is next to a major freeway and next to the Washington Square

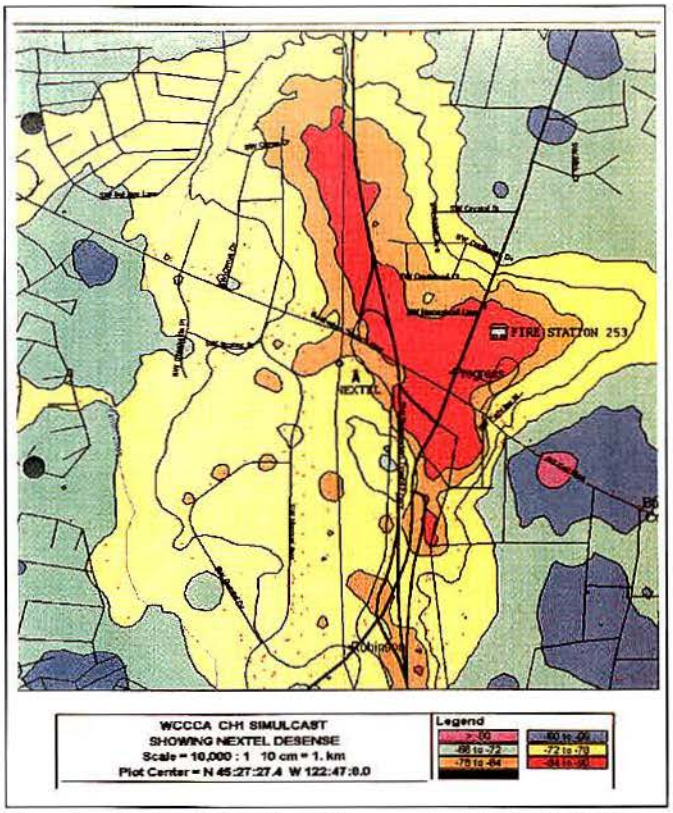

Figure 6. This signal strength contour map depicts the 800MHz coverage of WCCCA's system. The red area indicates what the agency first thought was a 'hole' in its radio system. Later, the area was found to match closely to the signal contour from the commercial site. The red area shows where the portable radios stopped receiving.

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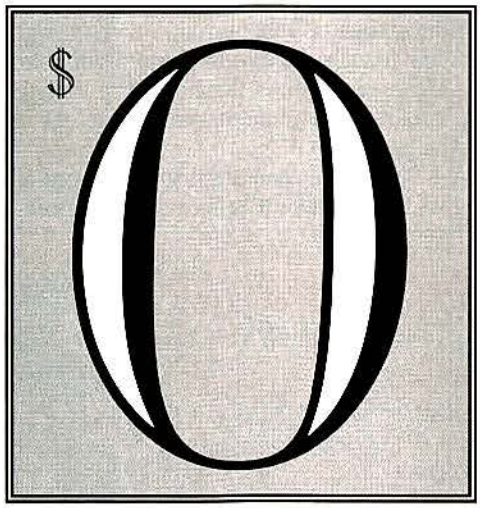

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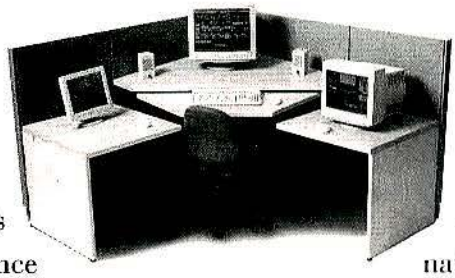

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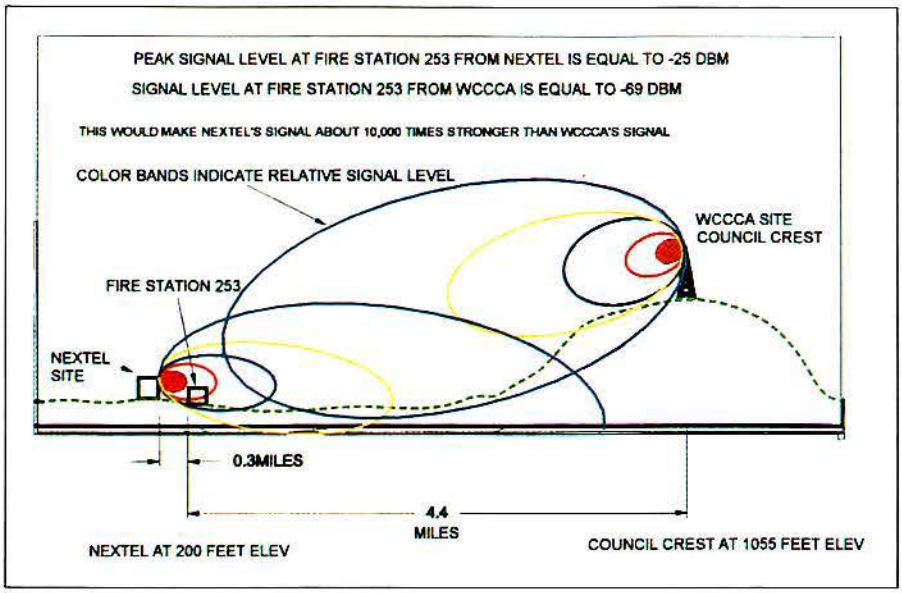

Figure 7. The geographic relationship between the Nextel site and the Washington County 800MHz repeater site. Usually, 800MHz trunked simulcast systems are located in high places (mountaintops) for maximum radio coverage. The commercial site's situation on the valley floor greatly increases the chances for creating interference.

shopping mall, where, as mentioned before, we have no in-building coverage.

The engine company is equipped with an 800MHz Motorola Spectra radio, an 800MHz Motorola VRM 600/DATA 911 mobile data terminal (MDT) and several 800MHz Motorola MTS2000 portable radios. The station is also equipped with an 800MHz base radio used for "tapping out" the station. ("Tapping out," a carry-over term from the old days of alerting stations by Morse telegraph, is the emergency alerting system that rings the station bells and turns on the lights.)

The engine company first complained to WCCCA Technical Services about poor radio communications. Its main complaint was that it was difficult to hear what fire dispatch was saying. This created a life-threatening situation because Station 253 was not always getting tapped out. The base radio was not always responding to the alerting signal.

WCCCA's technical staff began troubleshooting the problem. The usual procedures, such as checking antenna and receiver performance, revealed no evidence of a problem. Attention was then directed to the trunking system itself. At first, the WCCCA technicians thought there might be a simulcast phasing error. This, too, proved to be a dead end. The next area of investigation was determining the signal strength at, and around, Station 253.

The expected signal strength level should be about −65dBm at Station 253, This is based on calculations for ideal conditions (our closest trunking site is only 4.4 miles away), with an average of 58W ERP and with 9dB antenna gain and 3° antenna downtilt. As shown in Figure 5 on page 22, a Z-Technology R-505 field strength meter (range, 0dBuV to +110dBuV; accuracy ±2dB), a GPS receiver and a notebook computer were mounted in a jeep to log field strength readings of WCCCA's control channel #1 (860.7375MHz). (See Figure 6 on page 22) Computer analysis and mapping of signals

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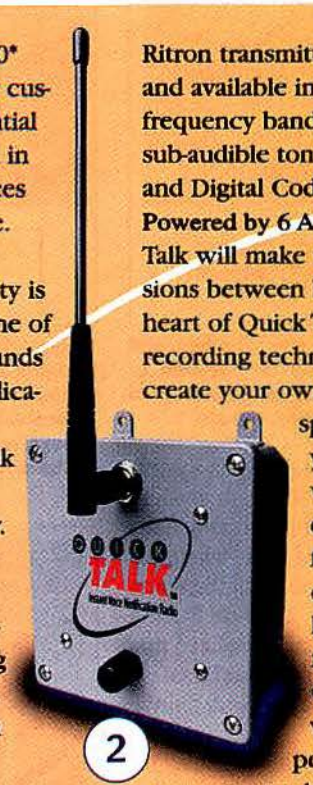

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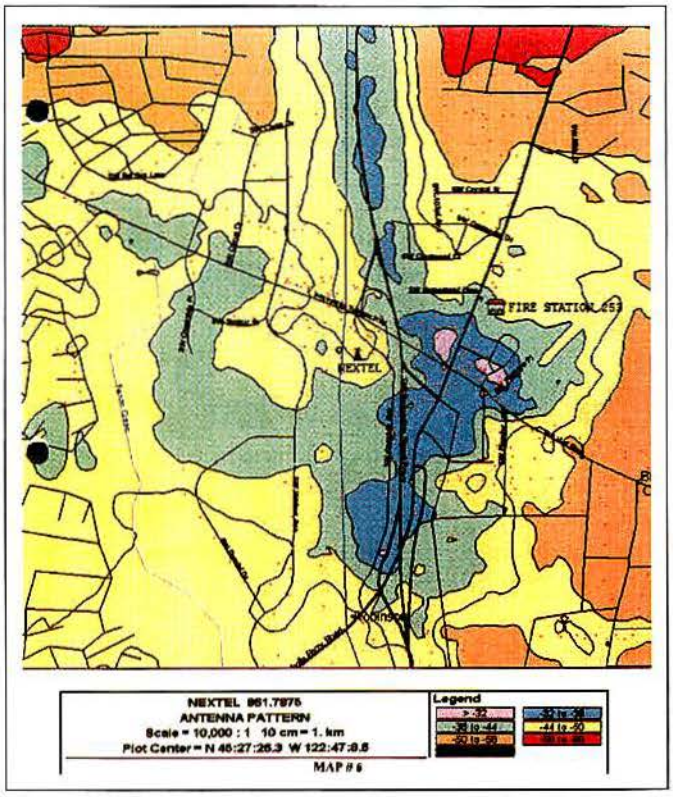


Figure 8. A signal-strength contour of the Nextel site. The blue and magenta plots show where Nextel's signal level is −38dBm or greater. Our tests demonstrated that in an area of greater than −38dBm, our portable radios stopped receiving any signals.

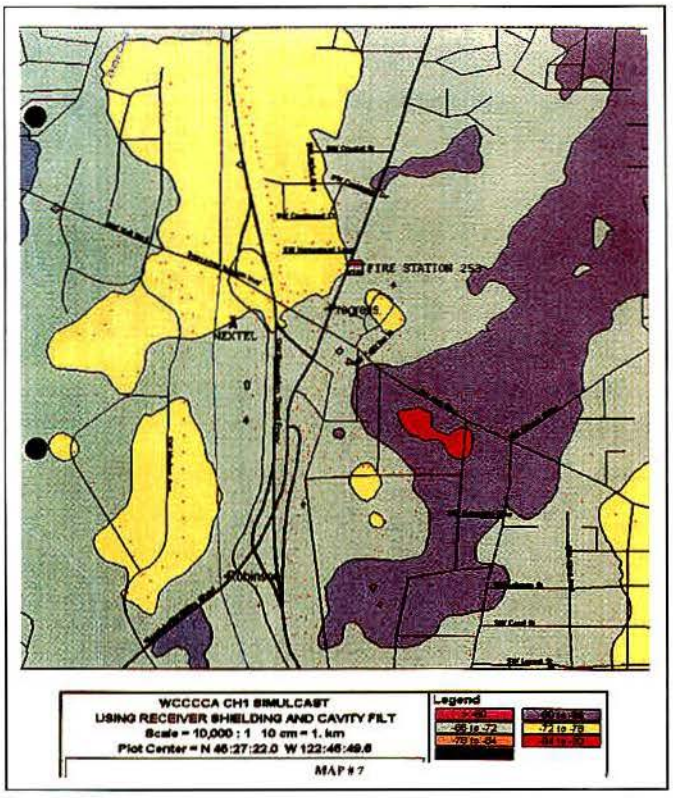


Figure 10. This contour map was generated to verify that WCCCA's 800MHz system actually had some radio coverage in this area. (Refer to the second test setup shown in Figure 3 on page 20.) By using extensive RF shielding and filtering, WCCCA was able to acquire enough readings in this area to demonstrate there was not a 'hole' in the coverage.

was performed with the STI-9000 Mobile Signal Analysis System from Survey Technologies. At first, the field strength reading around the station did not make a lot of sense. Some areas had the expected field strength level, and then there were areas where the signal dropped off to nothing. At first, WCCCA thought there was a signal hole in the simulcast system coverage. Because Station 253 has a relatively low elevation, WCCCA came to believe that this might be normal. However, because this involved public safety communications, WCCCA felt that it needed a more definitive explanation.

Two key issues led WCCCA to start suspecting an "outside" interference problem. First, it was discovered that the portable radios worked better inside the engine bay with the bay door closed. Second, the base radio got a more intelligible signal from fire dispatch using an inside antenna than when it was connected to the main outside antenna.

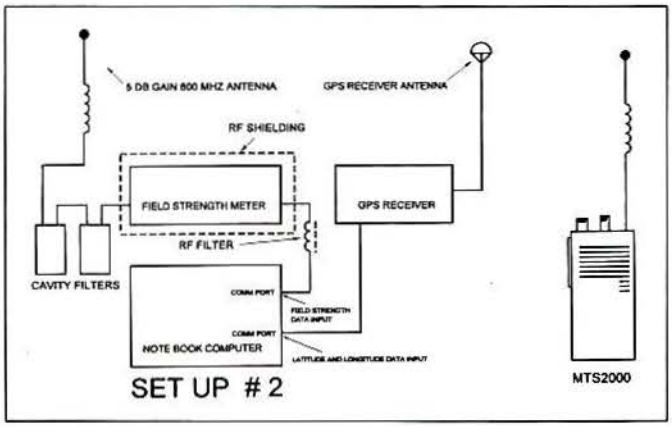


Figure 9. The same test measurement setup as shown in Figure 2, with the addition of cavity filters and RF shielding to overcome the massive commercial RF signal.

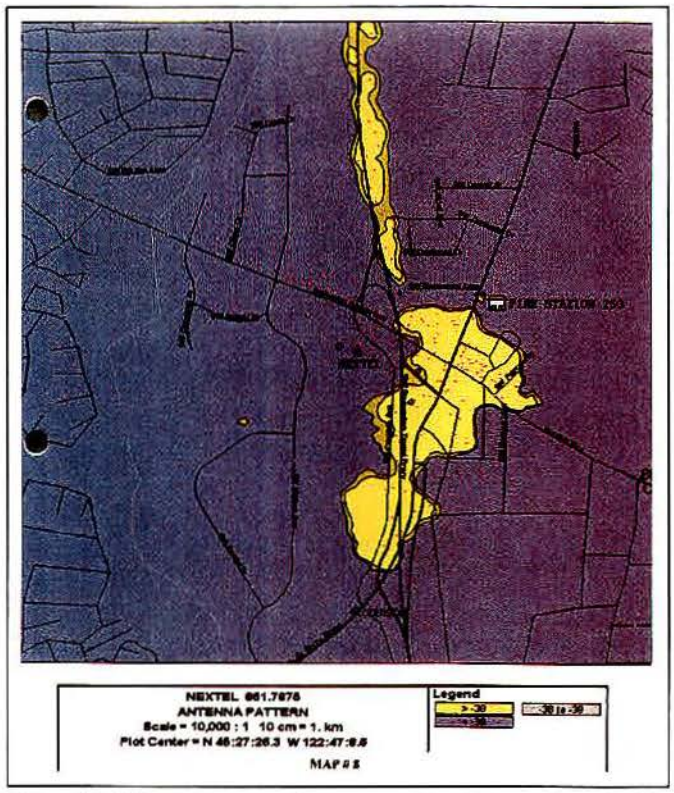
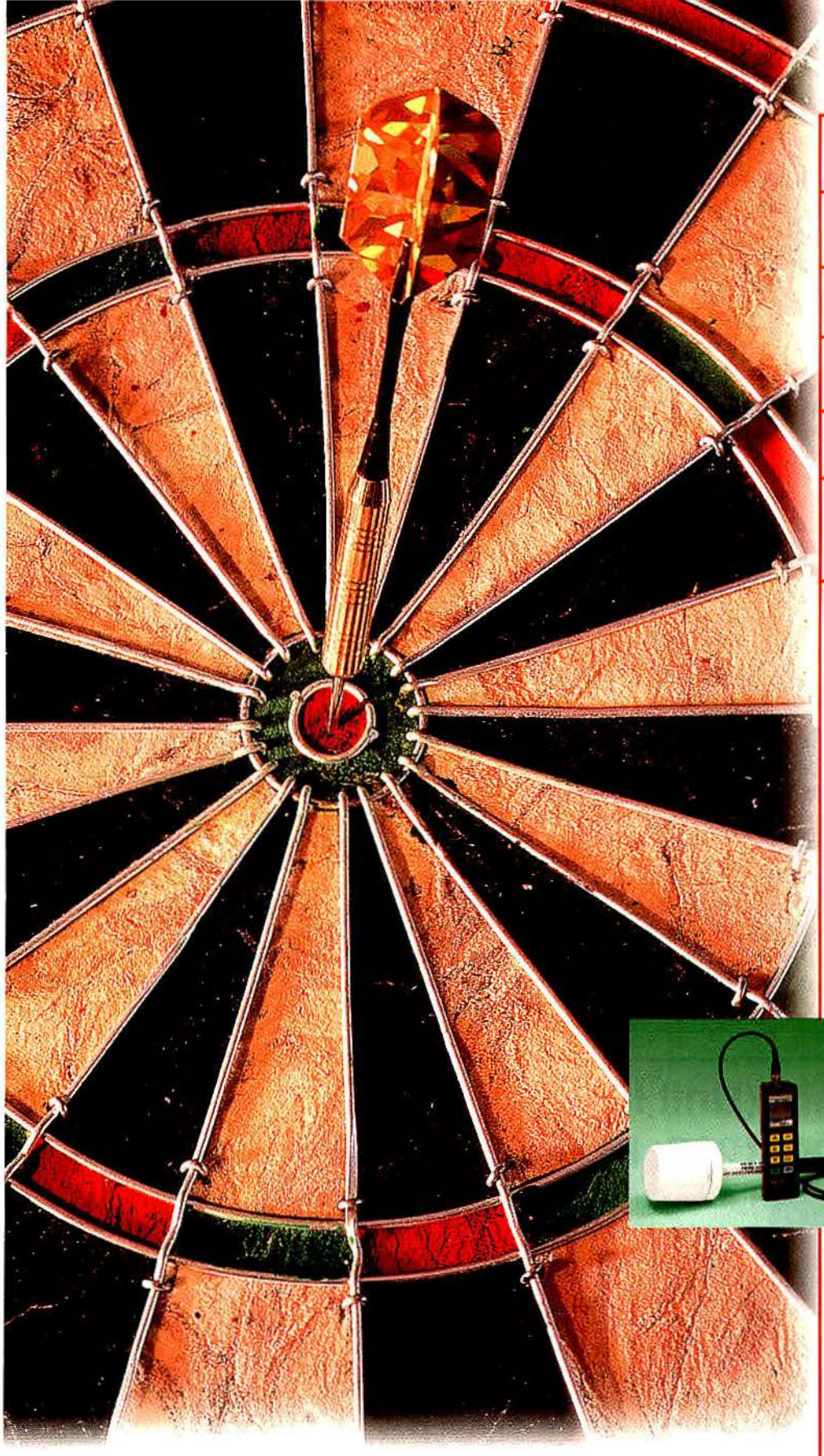


Figure 11. This contour map is a composite of those shown in Figures 9 and 10. The yellow area indicates where the WCCCA's radios stopped receiving. This area is where Nextel's signal strength is greater than -38dBm—roughly the same area where the radios encountered problems. ('Greater than -38dBm' can be *much* greater. Readings as high as -25dBm were sampled in this area, then averaged with the others.)



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Noisy neighbors

WCCCA's investigation of other radio systems in the area discovered that a Nextel Communications site was located about ¼ mile to the west of Station 253, as shown in Figure 7 on page 24. The site uses Motorola integrated digital enhanced network (IDEN) technology and 12 repeaters that constantly transmit data. The measured field strength at Station 253 from the Nextel site peaked out at about −25dBm. The signal level from WCCCA's simulcast system averages about −69dBm at Station 253. During the signal strength tests as shown in Figure 6, the meter would not function properly in close proximity to the constantly keyed commercial repeaters.

During the testing, a Motorola MTS2000 portable radio was also tuned to monitor WCCCA's control channel. When the field strength meter would cease to function, the portable radio would also cease to function. (The red area in Figure 6 indicates those areas.) That is why the portable radios worked better in the engine bay with the bay door closed. The metal bay door actually provided enough RF shielding to let the radio barely receive Fire Dispatch. With the bay door open, the radios lost all reception. When Engine 253 had to respond to an accident, the call was sent to the MDT, but as soon as the bay door was opened, mobile data experienced a high error rate, and the message was scrambled.

Also, because of the RF overload from the commercial repeater signal, the mobile radio on Engine 253 was unable to receive a clear signal from Fire Dispatch.

To verify the condition, Nextel agreed to a WCCCA request to shut down its site for a brief period. A portable radio was immediately able to receive Fire Dispatch loud and clear in the open air in front of the station. A receiver desense test conducted at the station indicated that the Spectra receiver was being desensed 20dB or more by the commercial site transmitters. We now faced a situation of harmful interference from a commercial source operating within FCC guidelines.

Mapping the effect

To map out the exact area of harmful interference being generated from the commercial site, The test procedure was repeated. This time, the field strength meter was tuned to one of Nextel's frequencies (861.7875MHz). Figure 8 on page 26 shows the antenna pattern from the commercial site. The blue area, which indicates an average signal level greater than −38dBm, corresponds roughly to the red area in Figure 6. This is the same area in which the portable radios would stop receiving.

To verify that WCCCA's trunking system actually provided coverage in the area of interference from the commercial site, some extra measures had to be taken. With the assistance of a local Motorola engineer, the measuring equipment was modified, as shown in Figure 9 on page 26.

The field strength meter was surrounded with an aluminum shield. RF filtering was added to all power sources and to data cables that were connected to the meter. Dual-cavity filters were also added to the antenna input. The field strength meter and cavity filters were tuned to WCCCA's control channel #1. Again, the entire area was driven to collect an entirely new set of data points, as shown in Figure 10 on page 26. The RF shielding and filter allowed the field strength meter to operate 90%–95% of the time in close proximity to the Nextel site. This verified that WCCCA's system was actually providing signal in that area. Figure 11 on page 26 is a composite of maps from the three-part measurement procedure. The yellow area shows the area where public safety's portable radios stopped receiving and where mobile radios received substantial interference and had difficulty receiving emergency broadcasts from Fire Dispatch.

Motorola review

An engineering review by Motorola concluded that it was "evident that Nextel's IDEN sites in Washington County are serious communications 'holes' in key urban areas for public safety communications."

The report detemined that the initial commercial activation of the first six channels presented heightened interference, but the expansion to 12 channels created the RF environment in which WCCCA's radios ceased to function.

The report also noted that following the short-duration system shutdown that Nextel made at WCCCA's request, Nextel used an HP spectrum analyzer to check the purity of its signals. The tests showed that the site was within specification and that spurious emissions or noise were below the noise floor of the analyzer (−118dBm). Measurements indicated that the 12-channel site produced 600W ERP composite total, using 2° downtilted omnidirectional antennas, also within specifications.

Bench tests by Motorola to duplicate the problem found that control channel reception was negligibly affected by high levels of interference (+13dBm and more) *as long as the interfering frequencies were spaced 1.5MHz or more* from the control channel frequency. Spacing tighter than 1.5MHz caused the control channel to blank in a symmetrical bell curve. Within just a few hundred kilohertz of the control channel, a

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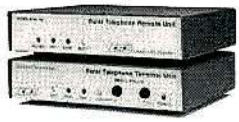

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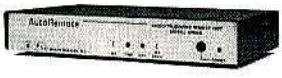

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Congress calls on FCC to address interference problems

UTC, the Telecommunications Association, has been educating congressional representatives on the dangerous interference problems that many utilities and pipelines currently face. The UTC has described cases in which utilities couldn't dispatch crews in critical emergencies because of interference.

The threat to public safety, therefore, prompted UTC to seek a regulatory solution that would protect the critical communications systems of utilities and pipelines from harmful interference. In December 1998, 11 members of Congress wrote a bipartisan letter to the Federal Communications Commission calling for swift action.

The letter read that "Interference from non-public safety-related radio users put at risk the lives and safety of utility and pipeline maintenance and emergency response crews," and threaten public safety. The letter stated that "in one particular case, a utility mobile dispatcher was unable to contact its field crews to shut off gas to a burning building because of continuous interference from a limousine paging service."

The number of cases of harmful interference continues to grow, and reportedly, 12 states have reported interference cases.

H.R. 4813, the "Critical Infrastructure Radio Systems Protection Action of 1998," has been introduced, directing the FCC to adopt rules to "ensure the on-going protection from harmful interference of private land mobile frequencies used by utilities and pipelines to protect life, health and property," according to the letter to Kennard.

The 11 Congressional representatives, including nine members currently serving on the influential House Commerce Committee, warned that should the FCC not move to address the problem, "Congress will be certain to take appropriate action when we reconvene." ■

varying number of interfering frequencies could blank the receiver with as little as −24dBm.

The engineering report concluded that "although the interference-handling capability of Motorola radio receivers is good, the sheer brute strength of the continuous-duty IDEN site transmitters planted in the same immediate vicinity and on the same subband as local public safety communications systems will spell problems for communications reliability in those areas. The issue is further aggravated by installation of IDEN sites in the same heavily populated areas (where) public safety also needs heightened communications reliability."

Moving toward resolution

This was the only site on which WCCCA performed extensive tests. Several other ESMR sites are located in Washington County, and spot-checking has found the same harmful interference. As commercial sites are added to improve coverage, public safety coverage will deteriorate.

Since the testing phase, Nextel has cooperated by cutting its ERP at the site back by half, and reducing the number of active channels from 12 to eight. Some frequencies were also relocated. This has decreased the zone of interference from ¼ mile to ⅛ mile at the local level.

In January, Motorola contacted WCCCA to arrange to send an engineering team assembled from its IDEN and RF design groups. After analyzing the problem in the lab, this team will follow up with real-world field tests.

A wakeup call to the the industry

The commercial mobile radio service in this case, Nextel, cooperated with local public safety in working toward a resolution of the interference issue. However, the same technical conflict is probably taking place all across the country. The national office of APCO has taken an interest in the problem, and Oregon's congressional delegation has expressed concern.

The FCC has looked at the problem, but concluded that because both parties in this case have valid FCC licenses and are operating within engineering specifications, there is nothing the agency can do. No one mentioned the band plan that contributed to the problem in the first place.

It's analogous to a shipping channel that is used for critical cargo. The government allows some contractor to build an underwater structure in the middle of the channel, just below the surface, and then does not tell the shippers that it is there.

The FCC, manufacturers, commercial service providers and public safety agencies need to examine the consequences to public safety, particularly in populous areas, resulting from certain band plans, power levels and site locations. Improved frequency coordination and RF design are essential to dealing with interference. ■

Computing in Connecticut

Connecticut public safety agencies pool their efforts to create a regional mobile data system that accomplishes goals set for the individual patrol unit, reporting requirements and links to state and national databases.

By Amy Kusiak

The Hartford, CT–based Capital Region Public Safety Council selected a challenging task for one of its inaugural projects in Connecticut, a state with a relatively small geographical area comprising 169 towns in just 5,000 square miles. The council initiated a program that will bring 39 traditional, independent-thinking, Yankee communities together to implement a truly regional mobile data system for the police departments in the Hartford area and potentially the entire state.

The council, because it is a member-run organization with no staff, entered into an arrangement whereby the Capital Region Council of Governments (CRCOG) actually provides operation management of the project.

From the project's inception, the Capital Region Chiefs of Police Association identified two overriding goals. First, the system had to be a definite step forward in the process of fully automat-ing a mobile public safety unit. "Fully automated" was defined as providing the same information processing tools regardless of whether an officer was in the mobile unit or the police station. Second, and equally important, the system had to address several critical *regional needs*. (See Table 1, above.) These needs included capabilities to report to and integrate with an ever-expanding group of national, state, regional and local public safety information systems. This article first examines the project as a *classic* mobile data system and then reexamines it in light of the broader implications

Kusiak is a marketing specialist for Telepartner International, Wallingford, CT. Teleserver is a trademark of Telepartner International. Bluelink is a trademark of MODAC.

Table 1. A regional system adds broader goals.

CLASSIC MOBILE DATA GOALS	REGIONAL SYSTEM GOALS
1. Redundant message-switch hardware and automatic error recovery.	1. Regional database for shared access to member data.
2. Field-incident and accident reporting with supervisor review.	2. Partitioned security by member organization.
3. Unattended wireless-software updates for mobile computers.	3. Incorporation of state-developed public safety software.
4. NCIC, NLETS and Connecticut COLLECT inquiries.	4. Support for more than 1,000 simultaneous users/message switch.
5. SNMP management interface.	5. Common table data definitions.
6. Single interface to multiple CAD and RMS systems.	6. Common format for key printed reports.

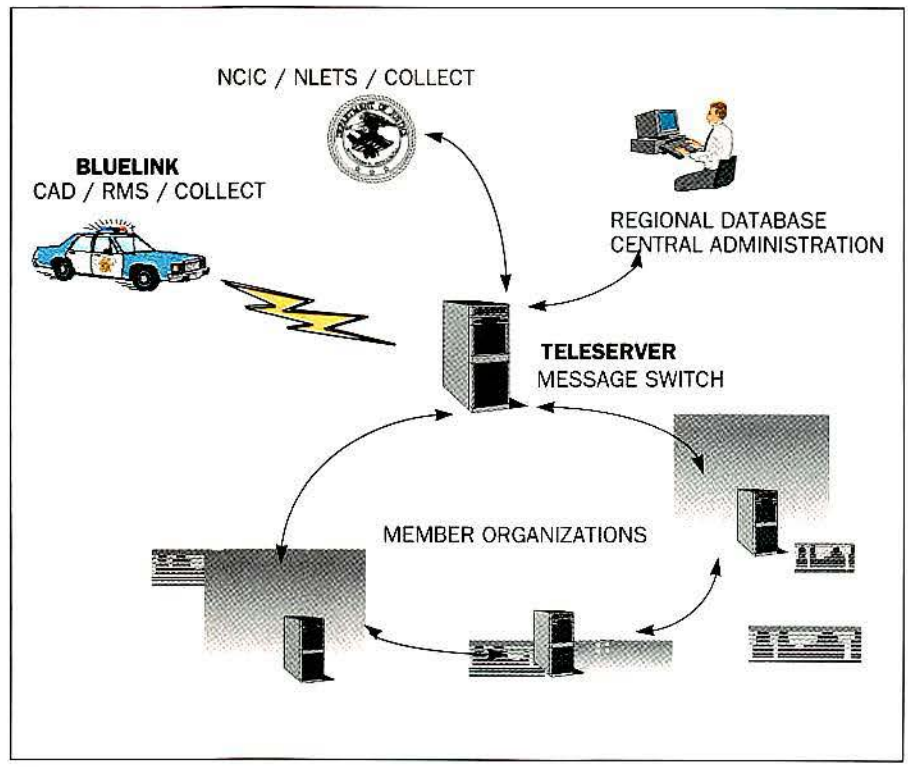


Figure 1. Regional system components.

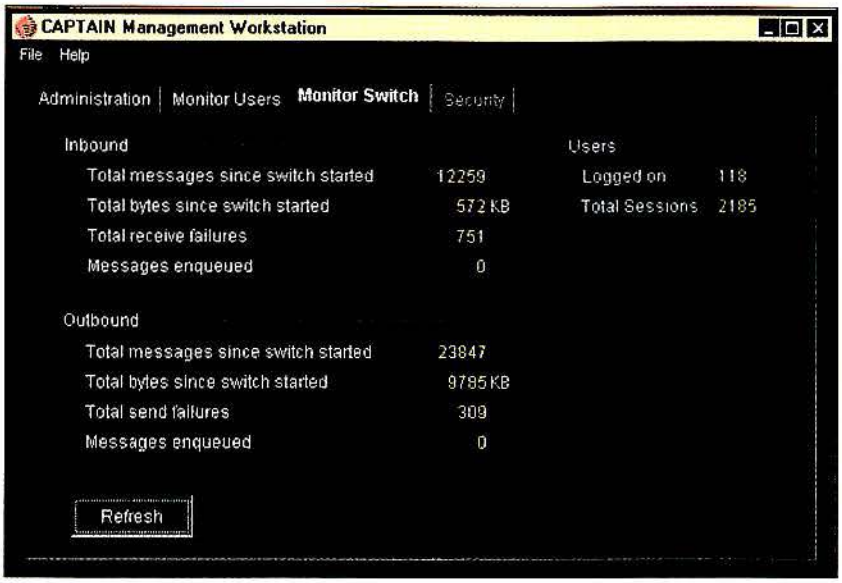


Figure 2. System status screen. This screen was captured at a busy time of day, most likely at the start of second shift when many patrol cars are typically on the road, and automobile traffic in the region is typically heavy. The remaining statistics are updated in real-time and serve to indicate general system load, typical message sizes and message failures. This information keeps the system administrator up-to-date on workload. When used in conjunction with the real-time alert messages, the Capital Region can deliver high service levels. In addition, should it ever be necessary to bring the message switch down for routine maintenance, this can be done without affecting active users.

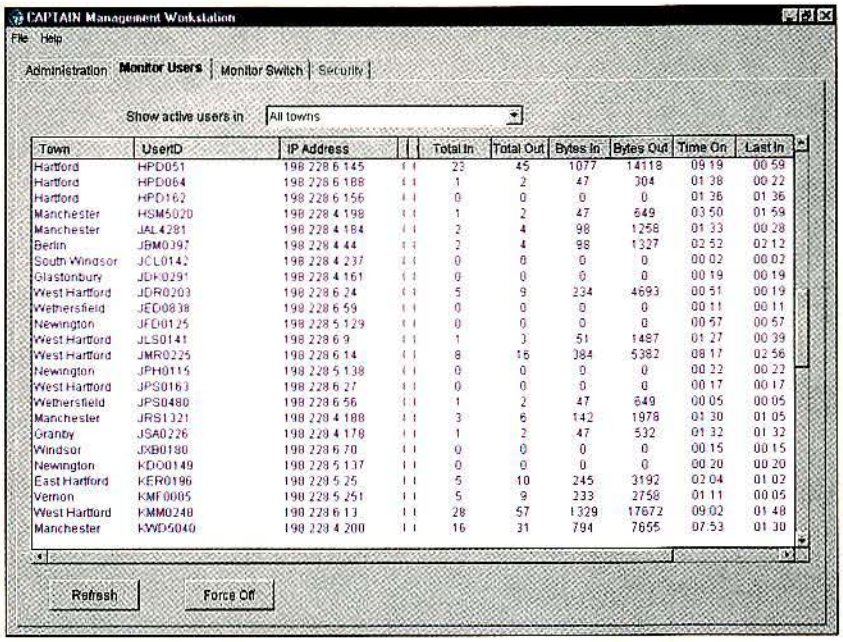
of a *regional information system.*

Mobile data system

Computers are not new to the police departments in and around Hartford. Public safety organizations have been using them successfully for many years. However, most systems in use were designed primarily to manage the information needs of a single organization. Access was limited to local, National Crime Information Center (NCIC) and National Law Enforcement Teletype System (NLETS) data. Furthermore, most systems had few mobile capabilities. From a regional perspective, each town was essentially an island, unable to share information electronically with neighboring communities.

Without mobile data systems, officers often complete more than one paper report for an incident, often duplicating many data entries among the multiple reports. In many cases, reporting requirements reduce the amount of time an officer can actually spend on patrol, which makes the process not only time-consuming but inefficient. Manual form completion also tends to be error-prone and difficult to manage.

Additionally, voice calls to department dispatchers were taking a significant time to process and were becoming an



Town	UserID	IP Address		Total In	Total Out	Bytes In	Bytes Out	Time On	Last In
Hartford	HPD051	198 228 6 145		23	45	1077	14118	09 19	00 59
Hartford	HPD064	198 228 6 188		1	2	47	304	01 38	00 22
Hartford	HPD162	198 228 6 156		0	0	0	0	01 36	01 36
Manchester	HSM5020	198 228 4 198		1	2	47	649	03 50	01 59
Manchester	JAL4281	198 228 4 184		2	4	98	1258	01 33	00 28
Berlin	JBM0397	198 228 4 44		2	4	98	1327	02 52	02 12
South Windsor	JCL0142	198 228 4 237		0	0	0	0	00 02	00 02
Glastonbury	JDH0291	198 228 4 161		0	0	0	0	00 19	00 19
West Hartford	JDR0203	198 228 6 24		5	9	234	4693	00 51	00 19
Wethersfield	JED0838	198 228 6 59		0	0	0	0	00 11	00 11
Newington	JFD0125	198 228 5 129		0	0	0	0	00 57	00 57
West Hartford	JLS0141	198 228 6 9		1	3	51	1487	01 27	00 39
West Hartford	JMR0225	198 228 6 14		8	16	384	5382	08 17	02 56
Newington	JPH0115	198 228 5 138		0	0	0	0	00 22	00 22
West Hartford	JPS0163	198 228 6 27		0	0	0	0	00 17	00 17
Wethersfield	JPS0480	198 228 6 56		1	2	47	649	00 05	00 05
Manchester	JRS1321	198 228 4 188		3	6	142	1978	01 30	01 05
Granby	JSA0226	198 228 4 178		1	2	47	532	01 32	01 32
Windsor	JXB0180	198 228 6 70		0	0	0	0	00 15	00 15
Newington	KDO0149	198 228 5 137		0	0	0	0	00 20	00 20
East Hartford	KER0196	198 228 5 25		5	10	245	3192	02 04	01 02
Vernon	KMF0005	198 228 5 251		5	9	233	2758	01 11	00 05
West Hartford	KMM0248	198 228 6 13		28	57	1329	17672	09 02	01 48
Manchester	KWD5040	198 228 4 200		16	31	794	7655	07 53	01 30

Figure 3. Display of active users in the region. This screen is a partial list of the users currently active on the system. The message switch tracks the key statistics for each user starting from the time each logged into the system. For example, the first user above, HPD051, has been active for 9 hours and 19 minutes. During this time, this user generated 23 inbound messages, which resulted in 45 responses. A response typically includes state and NCIC information. The IP addresses displayed are used for network diagnostic activities.

increasing part of the daily work. The new system had to not only shorten the access time, but it also had to provide more accurate data in an environment where the number of users and the rate of data access were rapidly growing. The planned system, using MODAC's Bluelink software, is designed to collect the data in a way that maximizes the computer's capability to assist the officer in the collection of information. Screens are controlled by the officer, table data is presented wherever possible, and duplicate data entry is eliminated. Most importantly, data entry is being redesigned to optimize the field officer's time, rather than simply making an electronic copy of an existing form for the mobile unit. Dispatchers already have noticed a reduction in traffic now that vehicle and person inquiries are being done electronically, and member organizations anticipate further time savings when the CAD system is activated.

Regional information system

The benefits to the individual cities and towns are enormous. CRCOG expects the total cost per town to be significantly lower than if each community purchased its own system. The council also expects significant reductions in total training costs because of efficiencies of scale. By

selecting a single system, each town avoids the lengthy process of selecting, testing and installing its own system. Prosecutors will see data presented in a uniform way and, as a result, will be encouraged to share more data regionally. The ultimate result is a less expensive network that provides more effective criminal justice information. (See Figure 1 on page 31.)

Before this implementation, a law enforcement officer in Hartford had no way of knowing that the same car he was about to stop was stopped moments earlier in Glastonbury or had been seen leaving the scene of a crime in East Hartford days earlier. CRCOG wanted the mobile system to give officers access to a regional database that would identify people involved in region-wide incidents. Ideally, better information might eventually help officers to prevent crimes from occurring. As one of the most important components of the design, this project will have a regional database designed to encourage sharing of certain data among members. As data are entered in the field, approved, and ultimately transferred to the member's record system, a copy of key information items will be added to the regional database.

Coordinating 39 member organizations during the specification, selection and implementation of the project was

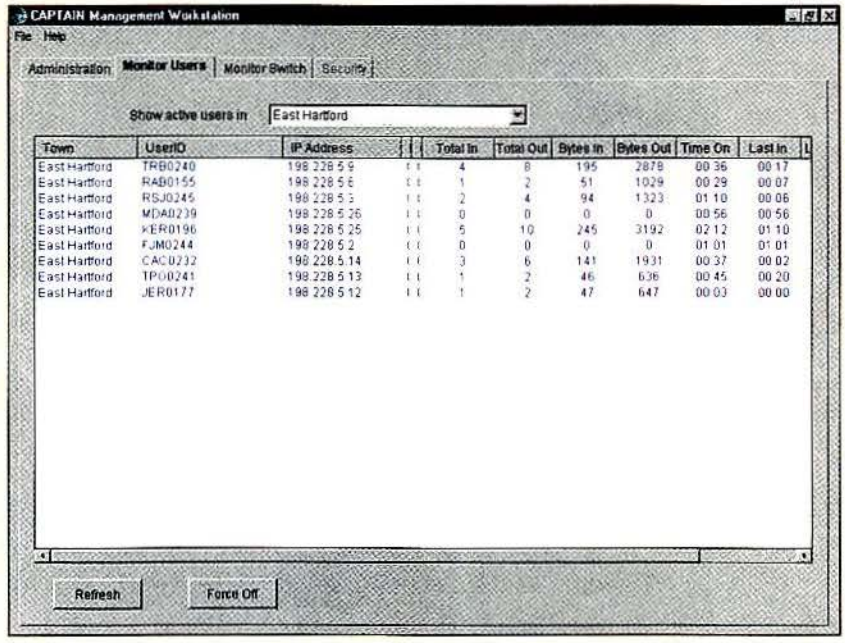


Figure 4. Summary of active users from a single municipality. While the Captain Project is a regional system shared by 40 organizations, there are many occasions when an organization wants to deal exclusively with its own use of the system. Because of the regional system design, each member organization controls and manages its own user community. This screen displays only the currently active users in East Hartford. Using this screen, and others, the local administrator tracks usage and manages security.

Mobile data deployment boosts MA warrant arrests

SPRINGFIELD, MA — The police department members of the Western Massachusetts Law Enforcement Council (WMLEC) have attributed increased warrant arrests and vehicle violation citations to mobile data terminal software that accesses a central system.

Installations began in March 1998 under the $2 million software contract, awarded to Marlborough, MA-based Cerulean Technology. Its Packetcluster Patrol software operates over Bell Atlantic Mobile's Airbridge wireless data network, which connects the patrol car laptops to the WMLEC landline network. The software is an open-architecture, standards-based product that can be used over both conventional VHF/UHF radio networks and CDPD networks.

WMLEC is a consortium of 27 police departments in Hampden and Hampshire Counties. Its member agencies cover about 608 square miles from the Vermont to the Connecticut borders with about 134 police vehicles. The departments range in size from a few officers to several hundred. With each police department within the WMLEC area at different stages of automation, council leaders said that they wanted to integrate a variety of CAD and RMS technologies.

Each member department now has its own system and can share information among the other agencies. Member agencies and dispatchers can access crime-fighting information from the field and communicate with each other through secure, real-time messages to assist in pursuits and investigations and to improve interagency coordination.

A public presentation and demonstration of the completed system was held in Springfield, MA, in October.

Longmeadow, MA, Police Chief and WMLEC Chairman Richard A. Marchese said "Armed with timely, accurate information, police officers can solve crimes faster and use their time more efficiently. Ensuring officer safety is a top priority with all police departments."

Marchese said the new software puts necessary information at an officer's fingertips within the security of the mobile unit, so officers are less likely to "walk into potentially dangerous situations."

The Springfield Police department reported that use of the new system has created a "dramatic increase" in the number of traffic citations issued, service of arrest warrants, and fines for uninsured and unregistered vehicles.

"With Packetcluster Patrol, our officers can run at least twice as many queries as they could using our voice dispatch system," said Springfield communications manager Carl Prairie.

Before the new system was installed, WMLEC member agency patrol officers had to wait as long as 20 minutes while dispatchers gathered background information from a headquarters–based terminal connected to the state criminal justice information system. The on-air downtime reduced the number of investigations and arrests officers could make because it limited them to fewer queries.

In addition to providing officers with real-time information, the mobile computer software allows them to file reports from their vehicles without having to return to the police station. ■

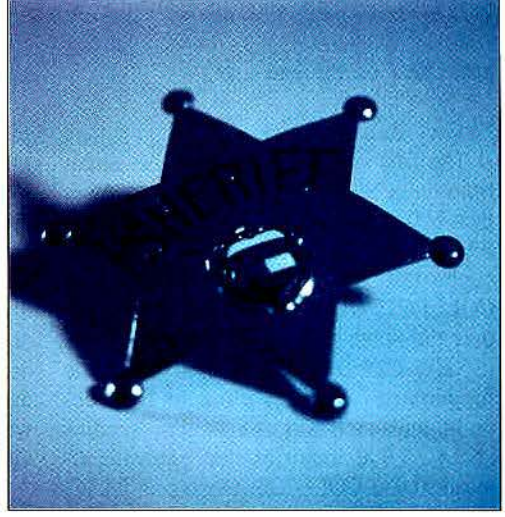
expected to be one of the most challenging tasks faced by the council. Early in the project, the members made a decision that went a long way toward creating and maintaining strong project support from every member. The group agreed that decisions would be made by representatives of the members, not by a small number of designated staff. While this often increased the work and delayed the decisions, it became one of the strongest aspects of the project. Because the members stayed involved with the process and made the decision themselves, support for the project started strong and remained strong.

Funding a regional project presented both great benefits and challenges. Because the population of the member communities represents a significant part of Connecticut, the state government agreed to provide funding by paying for network access, software and part of the hardware costs. However, the process of gaining this support lengthened the approval process at times. In the fall of 1994, Connecticut Gov. John Rowland included the provision for laptop computers in all police cruisers as part of his 10-point crime prevention program. Subsequently, in December 1995, the State Bonding Commission approved the initial $900,000 of their share of the program. In parallel, many individual organizations applied for, and received, "Cops More" program grants to acquire laptop computers. The process of building support for this funding added almost an entire year to the project.

Each member organization faces an ever-growing obligation to share data as a consequence of the National Incident-based Reporting System (NIBRS), and a series of legislated requirements for specific topics such as gang-related activities, family violence and drugs. Additionally, members are being mandated to provide data to state and national agencies in standard formats. This project tackled the reporting and data collecting tasks from the outset. The members decided to include a number of standard reporting forms in the project scope. These data collection needs were addressed by the software in the mobile unit, in conjunction with a significant amount of back-end reporting. (See Figure 2, page 32; Figure 3, page 33; and Figure 4, page 34.)

Regional design

Each of the 600-plus vehicles has vehicle-mounted IBM Thinkpad computers with Sierra Wireless modems and MODAC's Bluelink Windows 95 software. Telepartner International's Teleserver message switch, located in the Hartford Police Department's data center, runs under Microsoft NT on fully redundant hardware. All communications are Internet protocol (IP)-capable, including access to COLLECT and the mobile units. COLLECT is Connecticut's centralized public safety system, which accesses state, NCIC and NLETS information. A planned frame-relay network will connect member organizations to the system by year-end, and will also use the IP protocol. The system uses Windows NT security and is designed to recover all communications sessions in the event of any system failure without



any effect on the end users.

Project status

The first of three phases of this ambitious project has been deployed to more than 600 police cruisers in the 39 member communities. As of early 1998, the system supported inquiries to Connecticut's COLLECT, NLETS and NCIC databases over the Southern New England Telephone (SNET) CDPD network. Response time for inquiries averages close to five seconds, and each day the system handles about 25,000 inquiries that generate almost 30,000 COLLECT, messaging NCIC, and NLETS responses.

The project is closely following the planned schedule for the remaining phases. Planning for the database needed in later phases has been completed, and the Telepartner team has started development work on interfaces to the many CAD and RMS systems used by member organizations. Because all the hardware is now in place, subsequent updates will address software and training. Small updates and enhancements will be delivered wirelessly, while larger ones will be done via compact disc.

Other state agencies, interested in eliminating paper reporting in favor of electronic filing and exchange of information, have made inquiries to the council. Several towns beyond the original membership have expressed interest in joining the project. As the result of an offer made to all towns in Connecticut, several are in the process of installing the system to test in their municipalities.

Initially, the organization was concerned that it might be difficult to appease group members for the duration of such a large project. This was especially a concern because member towns had a strong desire to get the systems as quickly as possible. They were convinced they could save money and time and possibly lives. Further, the project went at a slower pace because of the sheer size of the group.

Surprisingly, Richard Porth, Executive Director of CRCOG, observed that "Holding the group together really never became an issue." He attributed that to the fact that "Members were always in control of the project, and they were convinced that a regional system would cost less and deliver many more benefits over time than any system an individual town could implement."

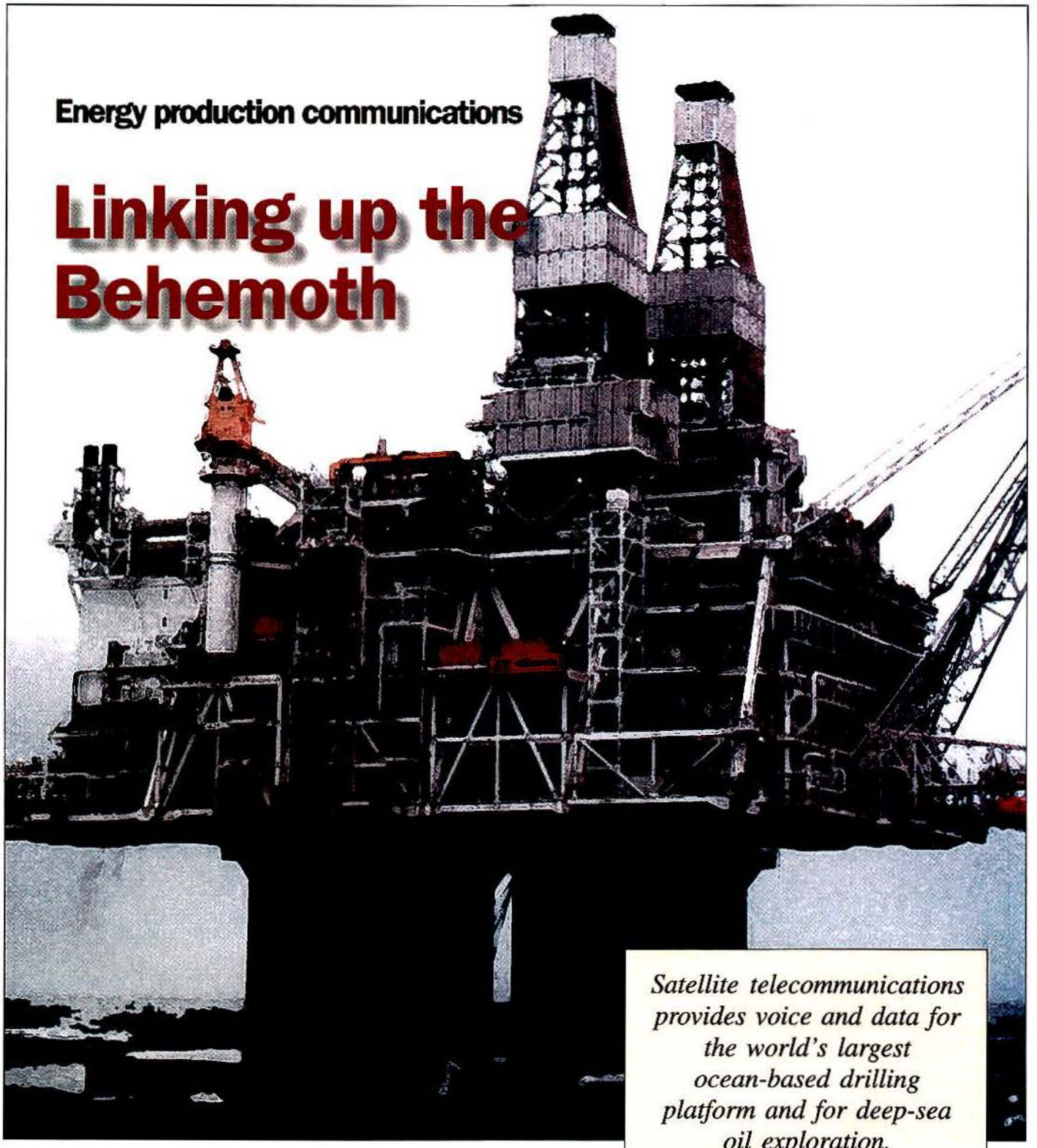
> **'Members were always in control of the project, and they were convinced that a regional system would cost less and deliver many more benefits over time than any system an individual town could implement.'**
> ***—Richard Porth, CRCOG***

Initially, the plan called for end-user support to be provided by each of the member organization's staff, with some degree of high-level support being provided by the larger, more experienced information services staff of a few members. During the pilot period, it became apparent that the support requirements for a project of this size would require constant support. Thus the team decided to contract with Telepartner for support services. Telepartner's support staff, on a trial basis, is now handling all reported problems and coordinating service, network and hardware vendors in problem resolution.

Information concerning this project can be obtained by contacting Richard Porth, Executive Director, Capital Region Council of Governments at 860-522-2217; Telepartner International at 800-935-3270; or MODAC at 860-247-3333. ■

Energy production communications

Linking up the Behemoth



Satellite telecommunications provides voice and data for the world's largest ocean-based drilling platform and for deep-sea oil exploration.

By Howard MacIntyre

Production and exploration in the oil and gas marketplace has become increasingly dependent on satellite-based telecommunications between offshore platforms and land-based headquarters. Besides real-time data transfer of drilling information and hydrocarbon accumulations, the industry routinely makes use of voice, fax and even video-conferencing applications.

MacIntyre is manager of oil and gas projects for Stratos, in St. John's, Newfoundland, Canada. He can be reached at **howard_macintyre@stratos.ca**.

Two oil operations off the coast of Canada have different broadband telecommunications needs. Mobile satellite technology fulfilled certain needs, while saving those operators money through cost sharing of shore-based hardware.

Energy production applications

An energy company's telecommunications requirements will vary, depending on whether that company is engaged in oil and gas production or in exploration.

For production applications, an operator drills a constellation of oil wells, penetrating different producing zones. There are generally more industrial processes and more workers involved in production than in exploration. A typical example is the Hibernia drilling and production platform, operating about 200 miles off the coast of St. John's, Newfound-

land, in the Grand Banks.

The North Atlantic behemoth

The Hibernia platform, which began providing service in 1997, produces nearly 150,000 barrels of oil daily. Half as high as the Empire State Building (three times as heavy) and containing more reinforcing steel than the Eiffel Tower, Hibernia is home to about 280 workers, rotating in three-week shifts, who require both business and personal communications. Radio requirements include aircraft control for helicopter transport and marine band communications with a fleet of vessels that steer icebergs away from a possible intercept.

As a production enterprise, Hibernia currently uses 512kbps of bandwidth for telecommunications, made available by Stratos, a provider of multinetwork mobile satellite services. The platform has a complete offshore wide-area network (WAN) and a broadband digital satellite link connecting it to the corporate offices in St. John's. Voice, data and other applications are multiplexed onto the link.

Joe Arsenault, senior telecommunications systems engineer for Hibernia Management and Development, said that one of the greatest demands placed on the offshore telecom system was not data, but telephone service.

"With between 200 and 300 employees on the platform, we get a significant amount of telephone traffic back and forth to the platform," Arsenault said. "We also have a fairly liberal policy in regards to employee telephone access for personal and business use. We'd like to think we provide our offshore personnel with a good level of connection to the mainland."

Besides telephony, Hibernia uses satellite technology to deliver drilling and well-evaluation data, in addition to the necessary operations data require to run the world's largest offshore oil processing and production platform. Data are collected on each well as it is drilled, in real time, using a process called "logging while drilling" (LWD).

LWD involves sending sensors down each well to monitor conductivity and other related data. Drilling and well-service contractors provide Hibernia with custom software that provides specialized graphical and numerical displays on high-resolution monitors.

The collected data are mirrored across a satellite link to Hibernia's data interpretation center in St. John's. Well specialists and geologists at the center can access the data—including the depth and location of the well—in real time. This information is used to determine the geophysical and geological features of the well and to anticipate the location of oil deposits.

Hibernia also boasts two full videoconferencing facilities offshore. One is used for day-to-day business communications; the other is a standby and can be used by medical technicians in case of medical emergencies on the platform.

Energy exploration applications

Exploration projects typically employ a single, semisubmersible drilling rig staffed by as many as 85 people. This rig drills one well at a time and may require only telephone and LAN connectivity to support its telecommunications needs.

Exploration projects typically use less bandwidth than production facilities. Commonly, these projects use 256kbps of bandwidth.

Searching for black gold

The Jeanne d'Arc Basin Operations Group is a consortium of oil companies including Mobil Oil, Petro Canada, Chevron Canada and Norsk Hydro. Named for an oil-rich geological structure off St. John's, the Jeanne d'Arc Basin Operations Group links local-area network (LAN) systems between offshore and shore-based facilities.

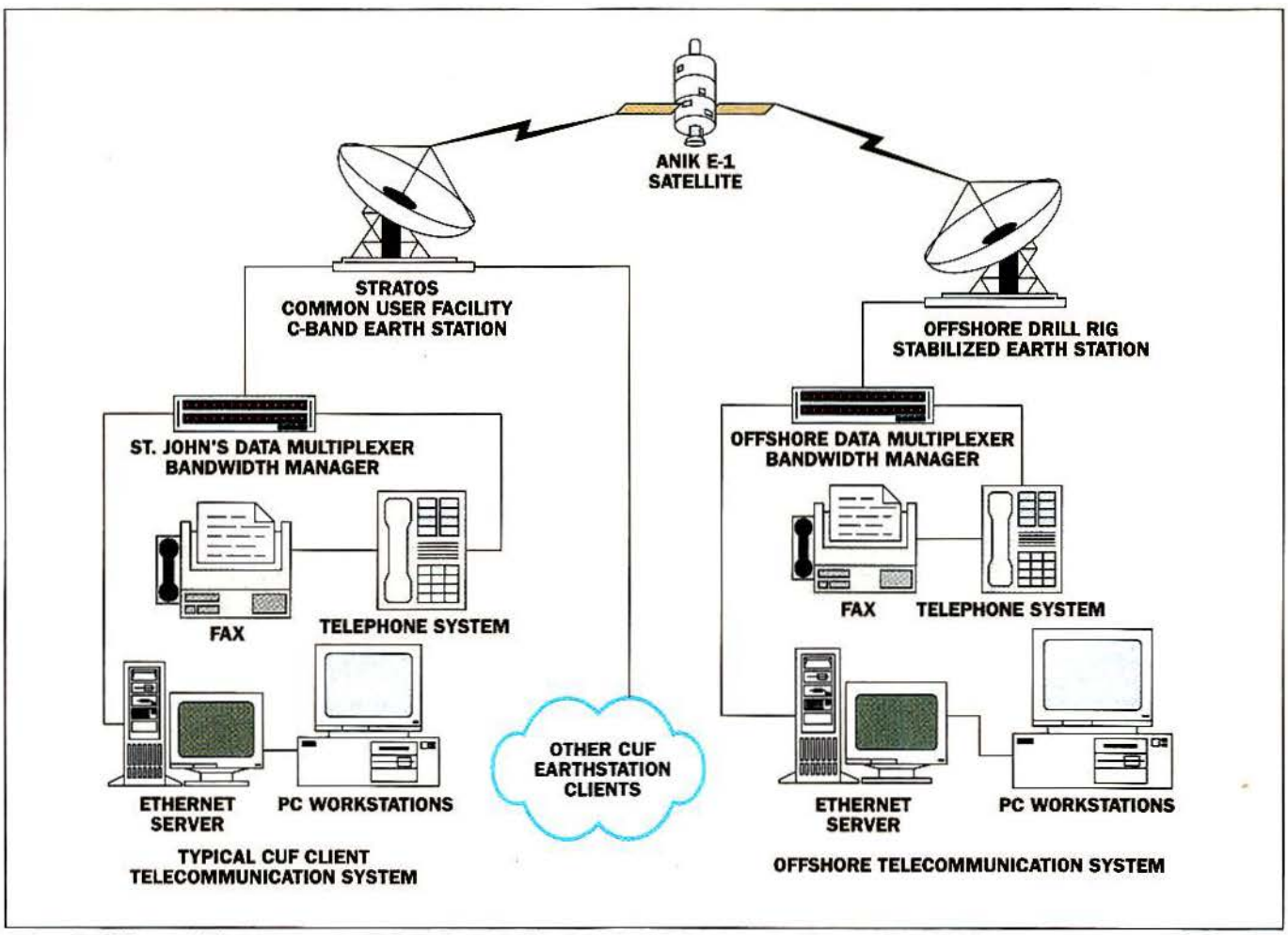


Figure 1. Offshore drilling rigs can be linked via a stabilized earth station to a shore-based common-user facility to provide a range of telecommunication services. Such applications can include voice, fax and even videoconferencing.

Roger Dugal, the lead well-operations engineer for the Jeanne d'Arc Basin group, said seven workstations on the offshore rig are connected with the LAN on shore, which includes another 15 workstations. The company's drilling contractor, Global Marine Drilling, Houston, has five shore-based LAN connections and six or seven stations offshore. These two separate LAN systems share bandwidth.

Like Hibernia, the Jeanne d'Arc group requires real-time data transfer on drilling and well parameters, such as depth and background gas readings. Using a wireline logging system developed by Schlumberger, as much as 1Gb of information can be transmitted at a time by Stratos, over its satellite link, to a shore-based facility. At that point, the data are analyzed and recommendations are forwarded to employees on the drilling platform.

In the Jeanne d'Arc case, 25% of the available bandwidth has been allocated to voice and fax service. The equivalent of six satellite voice lines (three to the operator, three to the drilling contractor) and one fax line use 64kbps of satellite space.

Alternatives

Offshore projects, by nature, are in remote locations, and terrestrial options, such as connecting to a cable, microwave or fiber optic network, generally are not workable. Alternatives are typically either mobile satellite services, such as Inmarsat, or a dedicated stabilized-base earth station on the offshore platform.

The cost for Inmarsat-B high-speed data can run as high as $10 per minute. Even if an operator rents a channel, and gets the deepest possible discount for a 24-hour link, airtime expenses can still cost hundreds of thousands of dollars per month.

One alternative is a dedicated, stabilized earth station (as shown in Figure 1 on page 38), which is a point-to-point, VSAT-type application operating in the C-band or Ku-band. Although the installation cost on an offshore rig may be as much as a $250,000, charges can run as low as $10,000 to $15,000 per month for airtime and access. The high upfront capital cost is offset quickly over a year, as compared to an Inmarsat solution. However, because Stratos provides multinetwork solutions, having Inmarsat terminals installed along with the C-band earth station ensures a low capital-cost solution for emergency backup communications.

A single Inmarsat terminal in the high-speed data mode can deliver a maximum throughput of 64kbps. On the other hand, VSAT applications allow for data rates of 1.554Mbps (comparable to T1 service). On an offshore platform, typical bandwidth requirements range from about 300kbps to 500kbps.

The compressed voice channel capabilities of digital satellite links allow for 8kbps compressed-voice channels. At 500kbps of bandwidth, that means as many as 10 telephone calls can be terminated shoreside while retaining sufficient bandwidth to operate a reasonably high-speed LAN between the offshore platform and the shore-based headquarters.

Cost control

To service oil and gas industry customers, Stratos constructed a C-band teleport and operations center in St. John's. The company's $1 million, 7.2m dish is capable of higher gain than smaller antennas. The C-band teleport provides service at lower airtime costs than its smaller L-band (e.g., Inmarsat) counterparts because the satellite requires lower power to transmit back to the offshore platform's C-band earth station, which in turn conserves overall satellite power.

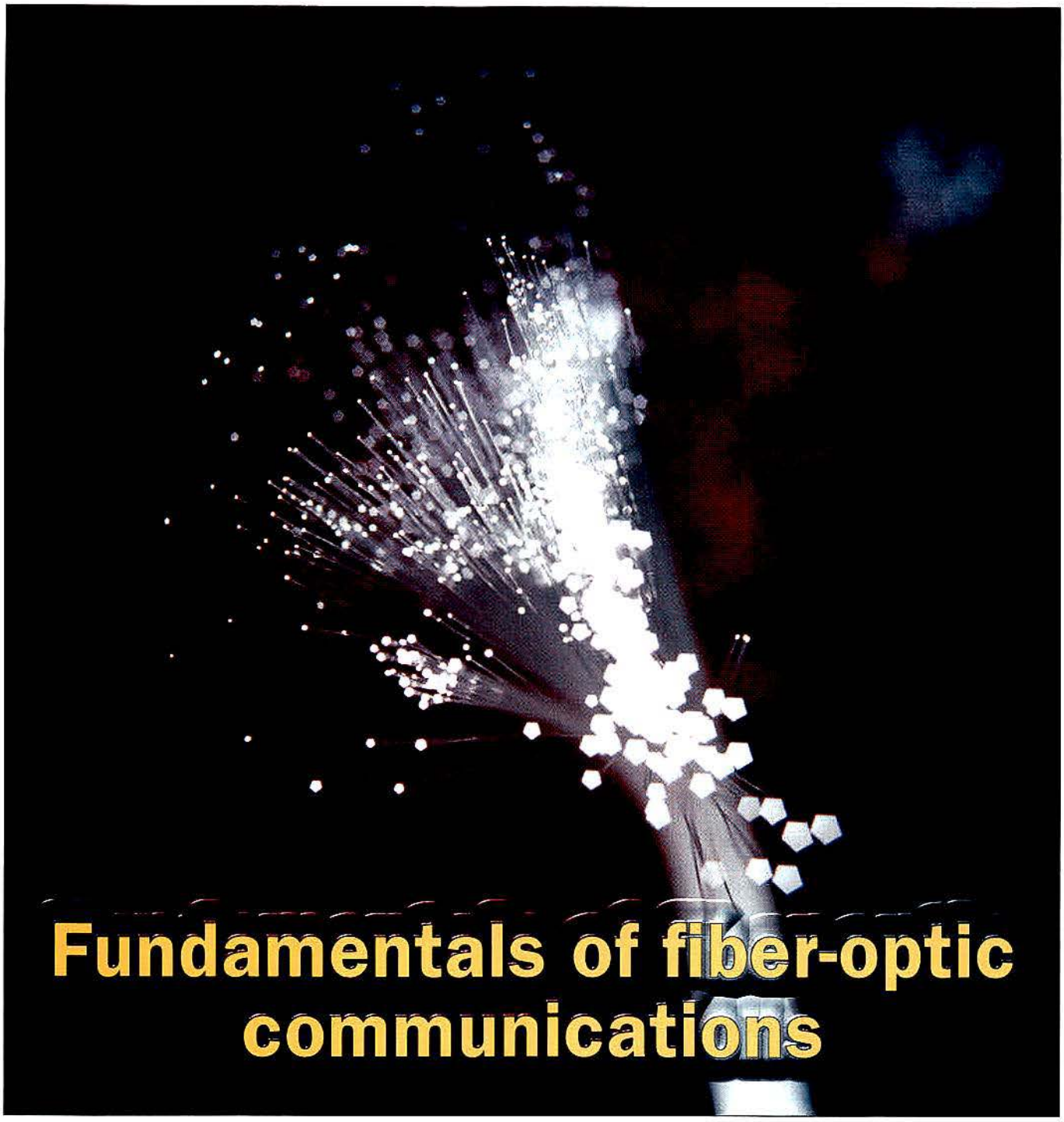
Hibernia is equipped with its own multiplexing equipment, and the company manages its own dedicated satellite link. Stratos provides an aggregated 512kbps bandwidth through a T1 digital circuit directly to the Hibernia premises. At that point, Hibernia manages its own telephone circuits and LAN bandwidth allocation.

This process works for Hibernia, but for companies that do not employ their own staff telecommunications engineers, a different service model is more likely. In this case, customers make use of the engineering resources of a satellite service provider to operate and manage the satellite service, end-to-end.

Regardless of the operating preferences, oil and gas companies can realize significant operational cost savings by using a single C-band teleport for all their communications.

For example, in addition to the Jeanne d'Arc Basin Operations, Amoco Canada, Terra Nova and Husky are scheduling more oil and gas exploration and drilling in the Grand Banks area. As each customer is added to the common-user, earth-station facility, Stratos can discount service to its customers while maintaining profitability.

This strategy of cost sharing has already proved successful. An Amoco Canada drilling project, begun in May 1997, overlapped the Hibernia project. Hibernia received a discount for service right from the start. When the Amoco project ended in January 1998, Hibernia returned to paying the original, non-discounted price. Now, both Hibernia and Jeanne d'Arc's Glomar contractor will receive a discount. When the Husky project goes on line, all three companies will realize savings from joint use of the C-band teleport. That's significant, considering the six-figure cost of using fixed point-to-point satellite services. That savings translates into lower operational costs overall, which in turn means a lower cost per barrel for oil production, and therefore greater margins for the oil companies using the services. ■



Fundamentals of fiber-optic communications

Part 1—An explanation of the basics of how fiber-optic cable works and a description of the common types of fibers, connectors and transmitters.

By Donald E. Koehler

Many radio service providers are faced with increasingly congested sites, higher levels of RFI/EMI and co-channel interference. Many large building owners are also looking for "seamless" internal radio communications for services such as SMR, PCS and cellular. Bringing the outside antenna and the inside service user together requires a wide range of technologies, with fiber-optic-based packages gaining increasing favor. This article, the first of two parts, examines fiber optic basics, including how fiber "works"; common types of fibers, connectors and transmitter/receivers; safety and testing considerations; and Web site addresses for further study. Part 2 will focus on some specific applications and equipment, including carrier links and extended coverage.

Koehler is a long-time communications technician. He teaches at the University of Alaska, Anchorage. His email address is **afdek1@uaa.alaska.edu.**

Fiber-optic cable is the application of the physics of light in a medium, in this case a coaxial fiber made of transparent material. How is this cable able to carry light energy great distances with little, if any loss? Have you ever been outside on a sunny day and looked into a swimming pool? Do you recall that part of the floor of the pool

was visible and the light reflecting from the surface obscured the remainder of the floor? This is because light striking the pool surface had changed *media*—from air to water. A more technically correct explanation would be that the density of the media through which the light was traveling changed. The light striking the water at or below the critical angle was reflected to your eyes. Light striking at or above the critical angle was refracted to impinge on the pool floor. Moving around the pool, you can see a change in the amount of floor visible to you as the angle of the light changes relative to your position. Fiber optic cable works on similar principle of reflections of light caused by changes in media density.

Commercial, long-haul, fiber-optic cable is made of ultra-pure glass. Manufacturing pulls this glass into a hair-thin *core strand* that is then clad with an additional layer of glass. The outside layer, or cladding, has a different density or refractive index. As shown in Photo 1 at the right, the inner core of the glass fiber cable carries the photonic energy, and the cladding provides the difference in density that allows the light to reflect further down the cable. Light must strike at an angle within a defined numerical aperture (NA), sometimes called a "cone of acceptance," to propagate to the distant end. For all practical purposes, this angle has been engineered into the cable, cable connector, transmitter or receiving device used. (See the sidebar below for the math used to calculate the NA.)

Fiber-optic cable comes in several "sizes" and types, as shown in Photo 2 at the right. The most efficient cable is "single-mode" fiber. The core of single-mode fiber is about 5μm to 8μm in diameter, and the cladding is 125μm in diameter. This yields excellent characteristics: a small NA, wide bandwidth and low attenuation. Fed by a laser, this cable typically operates at wavelengths of 1,300nm or 1,550nm. The cable covering is usually yellow, a holdover from when the Bell system was the primary user of this type of cable.

Multimode fiber has a core diameter of 50μm to 62.5μm and a cladding diameter of 125μm. This yields a larger NA, narrower bandwidth and higher losses within the cable. Fed by LED devices, this cable typically operates at wavelengths of 850nm or 1,300nm. It is usually orange. Finally, the lowest grade of fiber has a core diameter of 62.5μm to 100μm and a cladding diameter of 125μm. It is usually gray. This type of cable is suitable only for jumper cables or short runs because it has high loss and narrow bandwidth. The fiber core and cladding are engineered to the application and can be glass-over-glass, glass covered by plastic cladding or even plastic-over-plastic.

These glass fibers, coated with plastic for protection, are then placed into a buffer tube. The buffer tubes are laced into different types of cable. A "come-along," or pull member, of metal wire or stranded Kevlar is usually added. An outside PVC coating, colored for identification, completes the cable. These cables have at least two fibers, but some can have as many as 256 fibers, such as the larger cables used in CATV or data service applications. Fiber-optic cable can have many terminations or connectors.

The application or device supported by the fiber-optic cable will determine the

Photo 1. SC-type connector. Always cap the connectors when they are not in use, and always clean them before reattachment.

Photo 2. The identifying color of cable often denotes its use: single-mode, multimode or utility-grade fiber cable.

Fiber math

Bandwidth *(BW)* of a fiber cable is a function of the spectral width *(SW)* of the source, dispersion *(DISP)* inherent in the cable itself and length *(L)* of the cable run:

$$BW = 0.187/(DISP)(SW)(L)$$

Numeric Aperture is a *unitless* measurement. It is found as a function of the refractive indices of the cable in question.

Find the square root of the sum $[n_1^2 - n_2^2]$ where n is the refractive index. Then, find the cone of acceptance, with $\theta = arcsin(NA)$. Thus, $NA = sin(\theta)$. The answer is given in degrees.

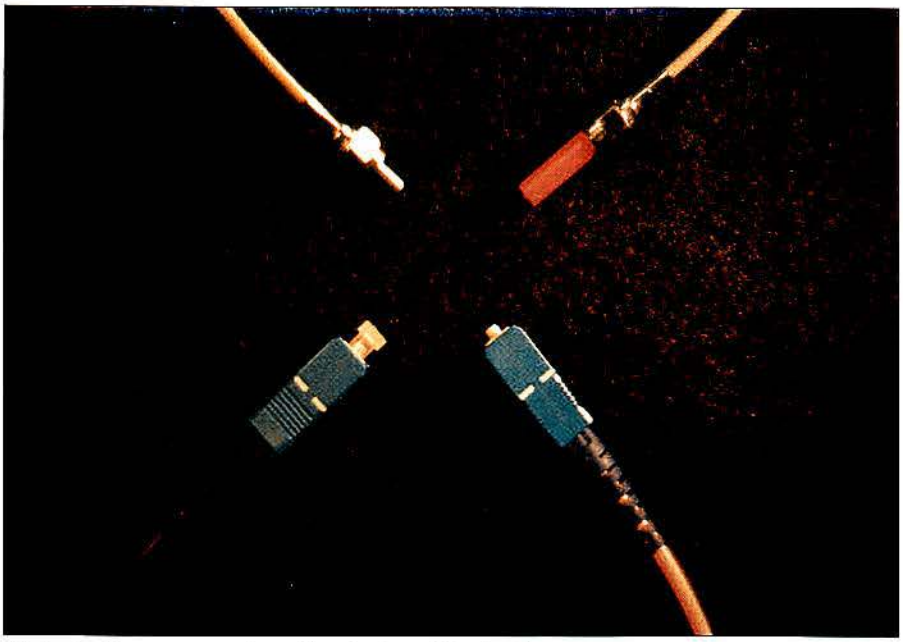


Photo 3. All connectors have ferrules to guide the fiber. Some are more pronounced.

type of connector used. The most common type of connectors a technician will see are based on a "ferrule," as shown in Photo 3, above. This component of the connector is the tip, or front, which holds the fiber in place and aids in the alignment of the fiber. Usually cylindrical in shape, the ferrule has a precision hole through the center. Type designations can be two-letter alpha designations, such as "ST" or "FC/PC," but they can also be longer, such as "SMC" or "biconic." The termination of the cable with a specific connector requires specialized equipment, training and a fair amount of craftsmanship.

To avoid expensive training for technicians, and to assure quality and to increase production, many companies purchase finished connectors that have a 6-inch to 12-inch "pigtail." This connector is then fusion-spliced onto the cable, ensuring constant splice-to-splice or splice-to-connector losses. Modern fusion-splicing machines are small, lightweight and semi-automated. Gone are the days of heat guns, UV lamps, smelly adhesives, portable microscopes and hand-lapping of connectors. For the technician in the field, this means increased productivity and fewer call backs related to "bad" connectors.

Now that the cable is completed, what devices are attached? Transmitters are either LED or laser diodes. First, and probably most common, are the LED-based transmitters. Modulated directly by a signal, they offer low power and a broad spectral dispersion, which leads to low coupling of light energy into cable. On the plus side, they are uncomplicated, inexpensive, require no cooling and use little drive power. LED transmitters offer no hazard to the technician or user. I know of no LED-based amplifier systems.

Laser diode-based systems, modulated by several schemes, offer excellent (very low) spectral dispersion, and they couple large amounts of energy into a fiber cable. Laser systems are more complicated, may require cooling of the laser device and may pose a hazard to the technician or user. The advantage here is extreme long-distance propagation of signal, about 80km to 100km, before amplification is required. Several laser-pumped, erbium-doped amplifiers are on the market. Although these amplifiers are not something that the average LMR/SMR technician will use, they are exciting as a demonstration of applied advanced physics.

Safety considerations

Safety in fiber-optic systems is straightforward. The laser devices used by most communication products are classified under government standards as Class 1 devices because they are considered "an enclosed working device"; that is, the laser energy is contained within the fiber. The equipment should be labeled with any and all required warning placards, which clearly indicate where any laser energy may be present anytime the system is energized.

Safe maintenance practices on these systems are usually covered in the equipment technical manual. Safety rules covered in any manual are important, such as:

- ❑ technicians *shall not* re-energize any equipment with laser transmitter(s) until they have ensured all work on sys-

Laser safety regulations sources

Health regulations

U.S. Department of Health and Human Services, Title 21 *CFR,* Subchapter J. Part 1040.10, "Performance Standard for Laser Products," and Part 1040.11, "Special Purpose Laser Products." (Note: Most communication equipment falls under these rules.)

OSHA regulations

U.S. Department of Labor, *Guidelines for Laser Safety and Hazard Assessment,* OSHA Instructional PUB 8-1.7, Directorate of Technical Publications, Aug. 19, 1991.

OSHA Instruction CPL 2-2.20B CH-2, Chapter 17: "Laser Hazards," April 19, 1993, Directorate of Technical Support.

U.S. Department of Labor, Bureau of Labor Standards, *Safety and Health Regulations for Construction,* Section 518.54, "Non-Ionizing Radiation," *CFR* 36 (75): p.7,348, April 17, 1971.

U.S. Department of Labor, *Laser Construction Standard (non-ionizing radiation),* Occupational Safety & Health Administration (DOL/OSHA): 29 *CFR* 1926.54.

U.S. Department of Labor, *Laser Eyewear Standard,* Occupational Safety & Health Administration. (Note: These rules are for high-power, *exposed* laser systems.)

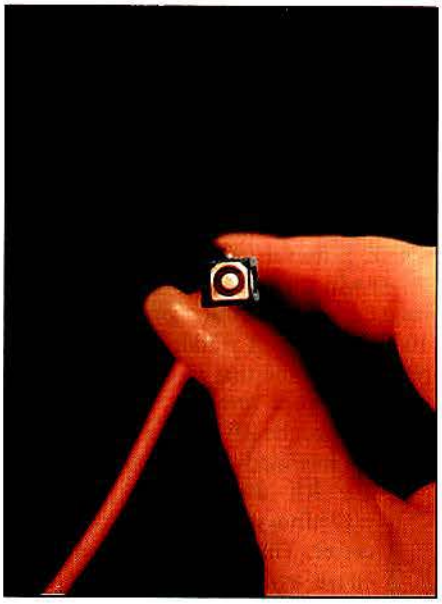


Photo 4. You can see the fiber in this connector, but never look in the cable end unless you know for sure that it is 'dark.'

tem is complete and all fiber cables are properly secured to equipment.

- ❑ technicians *shall not* look *into* fiber cables, equipment apertures or connectors unless the system or cable is *known* to be de-energized. (See Photo 1 above.)
- ❑ fiber-optic connectors and cable ends must be properly cleaned before attachment to system equipment.
- ❑ antistatic protective wrist straps must be worn when handling circuit packs or boards.

Certain other government and industry standards exist for worker protection. The sidebar references on page 42 are for employees who, while they may not perform direct maintenance on laser-based units, may be covered by federal "Right to Know" or "Hazard Communication" regulations.

Maintenance and testing

Testing in fiber-optic systems is limited to continuity checks and loss measurements. These tests are performed by using an optical time-domain reflectometer (OTDR) or a calibrated source and an optical power meter. Both are used to define losses in a fiber system caused by connectors, splices, cable defects and improper bends. The source/power meter is the least expensive means of testing. Several vendors, such as the John Fluke Co., make optical power sensor attachments for their meter lines. OTDR testing systems start at $20,000 or more, which is usually out of the reach of anyone not doing fiber installation or splicing as a primary business activity. For troubleshooting on larger systems, an OTDR can be rented or leased from several vendors. If you have a CATV system operator in your area, see if they use fiber-optic cable in their system. If so, they may be a source of low-cost assistance when performing fiber work. ■

Web sites

www.fotec.com/Index.html
This site offers a "Lennie Lightwave" testing primer and an extensive line of fiber-optic test equipment. While biased toward FOTEC equipment, it does offer good primer material.

http://corning.com/prod_svcs/index.html
Select Fiber 101 to learn about the history of optic cable and how Corning glass is used to make the cable.

www.metrotek.com/test.htm
This is one source of affordable fiber-optic test equipment.

Further pursuit with a search engine using a keyword search for "fiber-optic," "optic cable," "fiber-optic test equipment" or "glass-fiber cable" will yield many more sites to visit—enjoy.

Receiver front-end characteristics

By Harold Kinley, C.E.T.

The old slogan, "It's what's up front that counts," certainly holds true in the design of radio receivers. Under ideal conditions—low site noise, moderate-to-strong desired signal and no strong off-channel signals—almost any receiver will perform well. However, under less-than-ideal conditions, the design of the receiver front end becomes critically important. Design of the RF amplifier as well as front-end selectivity determines much of the operating capabilities of the receiver.

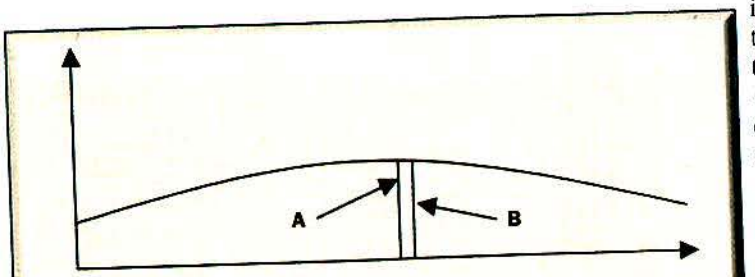


Figure 1. Relative frequency vs. amplitude response of wideband receiver front end.

Wideband receivers

Wideband receivers designed for mobile use can cause significant problems when used as a base station receiver. If you are forced to use a wideband receiver for a base station, be aware of the limitations and weaknesses of such an arrangement. Many wideband mobile receivers have "wide-open" front ends. That is, there is little selectivity up front. Some wideband receivers use electronically tuned resonant circuits that use a varactor diode tuned by a control voltage as the receiver operating frequency is changed. Other receivers might provide one of more front-end "windows" that are changed or shifted for certain frequency ranges.

Intermod rejection

If you are comparing the specifications of a receiver with a wide front end with those of a receiver with a narrow front end, you might be a little misled. The front-end selectivity is critical to good intermodulation performance. The more tuned stages ahead of the first active component (RF amplifier), the better the intermodulation rejection capability of the receiver will be, as long as the mixing signals fall out of the passband of the front end. If you look at just the receiver specifications, you might interpret that the intermodulation rejection figure of a specific wide front-end receiver is almost as good as another one with a relatively narrow front end. However, this doesn't tell the whole story. Suppose we are using a narrowband receiver and that the third-order intercept point for the RF amplifier is +10dBm. Further suppose that a signal at the first adjacent channel above the desired frequency is present at the amplifier input at a level of −20dBm. Let's call this signal *A*. (Refer to Figures 1–3.) Also present at the amplifier input is a signal (*B*) that is two channels up from the desired frequency at a level of −30dBm. Signals *A* and *B* will produce an intermod product ($2A - B$) at a level of −90dBm on the receiver frequency. When using the same signal inputs on a receiver with a wide front end, you might get similar results. However, a comparison of the receivers, using signal inputs far-removed from the center frequency, will show a significant difference in the results. Suppose for the narrow front-end receiver that the receiver is tuned to 152MHz and that signal *A* is 154MHz and signal *B* is 156MHz. Then the third-order intermod signal, $2A - B$, is equal to the receiver's tuned frequency, 152MHz. The wide front-end receiver will stay essentially the same, using the same signal levels at the input to the RF amplifier that were used in the previous example. However, the narrow front-end receiver will attenuate these out-of-band signals. Let's assume that signal *A* is down by 10dB to a level of −30dBm at the RF amplifier input and that signal *B* is down by 15dB to a level of −45dBm at the input to the RF amplifier. The level of the intermod signal at the output of the RF amplifier is down to −125dBm in the narrow front-end receiver. This intermod signal would cause much less trouble than the intermod signal of −90dBm in the wide front-end receiver. The bottom line is that receivers with wide-open front ends allow more signals to reach the input to the RF amplifier at a higher level. This increases the odds of intermodulation interference occurring.

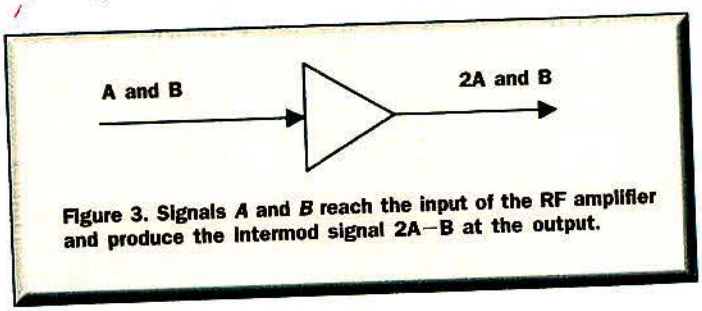


Figure 3. Signals *A* and *B* reach the input of the RF amplifier and produce the intermod signal 2A−B at the output.

Desensitization

Receiver desensitization occurs when a strong off-channel signal overloads a receiver front end and thus reduces the sensitivity to weaker on-channel signals. Receiver *desense* is usually measured by injecting an on-channel signal to produce 12dB SINAD at the receiver output. This is the *reference sensitivity*. Then the signal generator is increased by 3dB to produce a better-than 12dB SINAD at the receiver output. Then an off-channel (one of the adjacent channels) signal at a

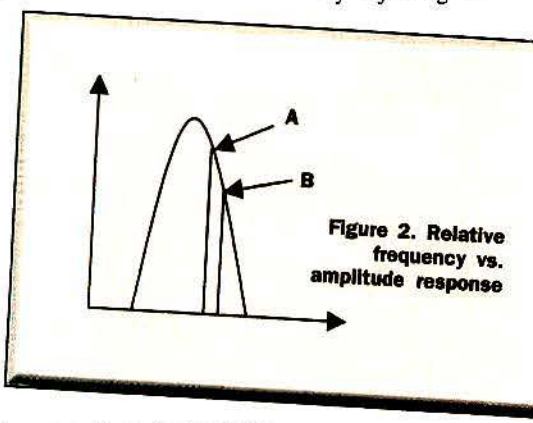


Figure 2. Relative frequency vs. amplitude response

Kinley, a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, which is available for direct purchase. Write to 204 Tanglewylde Drive, Spartanburg, SC 29301. Kinley's email address is **hkinley@aol.com.**

different modulating frequency is applied through a combining network to the receiver input. The off-channel signal is increased in amplitude until the SINAD meter again indicates 12dB SINAD. The difference in the level of this *undesired* signal and the *reference sensitivity* is the *desense figure* or *adjacent channel selectivity*. In one sense, this could also be called *dynamic range*, although this term is used to refer to a number of things regarding a receiver.

In a receiver with a wide front end, the undesired signal generator can be set several megahertz away from the on-channel (desired) signal generator and still cause desense. A practical example of this happened to one of the users of a repeater system. The repeater input was several megahertz down from the repeater output. While standing next to his mobile radio and using a walkie-talkie to "hit" the repeater, the user could not hear the repeater in the mobile radio until the walkie-talkie stopped transmitting. The walkie-talkie output was desensitizing the mobile receiver even though the receiver frequency was several megahertz away from the walkie-talkie output frequency.

Many times the phenomenon of receiver desense goes undetected. That is, the receiver never "hears" the desired signal and the operator might never be aware that there was a problem. In a mobile unit, the vehicle might have been near a powerful transmitter a few megahertz away from the receiver operating frequency, and the operator was never aware that desense was occurring in his receiver. When asked why he didn't respond to a call, he might answer that he didn't hear your call. This can create problems both from the personnel standpoint and technical standpoint. The technician is called to check his radio, and no problem is found. Is the receiver intermittent? Is the vehicle operator lying? Is the radio technician incompetent?

Parameters such as desense, intermodulation immunity and dynamic range all are interrelated. The design of the receiver front end has a great bearing on all of these parameters. In receivers with a wide front-end design, users must be careful to reduce the possibility of overload from strong, off-channel signals. Avoid using a receiver with a wide front end as a base station—especially at a site with many local transmitters. If you must do so, then use a couple of bandpass cavities ahead of the receiver. If you are operating single-frequency simplex, it can help the site noise problem if you run the transmitter through the cavities also.

Until next time—*stay tuned!* ■

Eastern states APCO meets in South Carolina

The South Carolina APCO chapter presented the Eastern States Regional Conference at the Kingston Plantation Embassy Suites in Myrtle Beach, SC, January 18–20. Seventy-one vendors participated, and in addition to the 403 fully registered attendees, 200 to 250 participants attended with day passes. Thirty sessions were offered throughout the conference with topics ranging from stress management to TSB 88.

Conference Chairman Frank Brand said that he wanted to offer sessions multiple times to allow attendees the opportunity to see more sessions rather than having to choose between several offered at the same time.

"I think the sessions were well received. The "stressed desserts" session had people bringing in more chairs to make room for everyone. We had about 40 people in the biggest session; the smallest had five," he said.

Attendees at the "Y2K Readiness" session, presented by Bill Fivek of Motorola, learned how to systematically assess Y2K compliance of all aspects of a public safety system to avoid any glitches that would lead to large complications and liability.

MRT's editorial board member, Fred Griffin, gave a presentation called "Dos and Don'ts of Communications Project Implementation," a step-by-step guide on the phases of seeing a project through from the initial decision to implement to the final review based on the average day in the life of a public safety professional. As a bonus, Griffin included a quiz with monetary rewards and a brief sailing lesson.

He said that implementers needed to realize that projects will almost always cost more and be more demanding than originally anticipated. He also warned that implementers should not try to go it alone on their projects.

"You will need specialized help," he said. "You can't know all of the inside information that consultants do."

Mobex, Bechtel join to offer services to utilities

Mobex Communications, Lafayette, CA, and San Francisco-based Bechtel Enterprises have teamed up to offer advanced wireless telecommunications services and systems to utilities. This partnership also offers the potential for utilities to create new revenue with telecommunications assets.

Mobex is a national provider of systems integration and specialized mobile radio (SMR) services. Bechtel Enterprisees is the project development, financing and ownership affiliate of The Bechtel Group, a global engineering and construction company. The combined resources of Mobex and Bechtel give utilities access to services ranging from design of customer billing systems to the construction of massive telecommunications networks.

Deregulation and impending competition are forcing utilities to reduce costs, while pressure from stockholders is compelling publicly held utilities to increase profits. The Mobex-Bechtel alliance provides new, customizable strategies that enable utilities to use their telecommunications systems in ways that best meet their needs. These strategies include simple cost-savings recommendations, asset management recommendations and programs, lease-back programs and revenue-generating opportunities.

800MHz licensees move for relocation stay

A motion was filed on January 27 to stay the Wireless Telecommunications Bureau's initiation of the negotiation period for relocation of incumbent licensees in the upper 200 800MHz SMR channels by EA licensees throughout the United States. The motion was filed by Schwaninger & Associates on behalf of the members of Small Business in Telecommunications and individual companies Applied Technology Group, Fresno Mobile Radio, Madera Radio Dispatch and Cumulous Communications.

The plantiffs, who hold the incumbent licenses for the upper spectrum, fear that those who were awarded upper spectrum channels in the December 1997 auction may not have unencumbered ownership of the lower spectrum channels they intend to trade. If problems do arise, those left with the "bad" spectrum will have no means of obtaining "good' spectrum equivalent to what they originally had.

The motion contends that a grant of stay would merely maintain the status quo until those who are being relocated can be ensured that they will have usable spectrum, risking no harm to anyone.

Precedent requires the request for a stay to demonstrate that pending challenges are likely to prevail, incumbent licensees would suffer irreparable harm if a stay is not granted, other interested parties would not be harmed if a stay is granted, and public interest favors a stay of the commencement of the voluntary negotiation period for the relocation. The motion contends that all four requirements have been successfully supported.

FCC Notes

FCC grants construction extension in part, denies other provisions in part

Southern Company requested an extension to continue construction of its wide-area SMR network that incorporates business and industrial/land transportation channels. It was granted in part and denied in part. Southern's request was to extend its original five-year extended implementation period an additional five years, or until the Commission makes the 800MHz business and I/LT channels available for auction. The commission granted the extension until the effective date of final rules implementing the Balanced Budget Act of 1997 with respect to the licensing of 800MHz Business and I/LT frequencies.

Commission gives unauthorized radio operators cease-and-desist order

Lewis B. Arnold of Chewelah, WA, and Mark A. Rabenold of Oroville, WA, were each ordered to "cease and desist" from unauthorized operation of radio stations on 95.3MHz and on 105.1MHz, respectively. Each was fined $11,000 for "willful violation of section 301 of the Communications Act of 1934."

Commission denies waiver request

The commission denied Jeremy Greene's request for a waiver of the competitive bidding rules and the bid withdrawal rule regarding the 220MHz service license. Greene will be subject to the balance of the payment when License BEA 160, the Los Angeles-Riverside-Orange County, CA, E-block market license, is reauctioned and the actual default payment is determined.

Greene had submitted and later withdrew the high bid. No subsequent bids were placed. He submitted a letter to the commission requesting that it award the license to him for a lesser amount than his withdrawn bid. Not only was Greene's request denied, he must also pay a $9,300 bid-withdrawal fee. Greene did not show that unique circumstances were involved and that there was no reasonable alternative within the existing rules.

Commission moves to portals (finally)

After years of deliberation, the FCC has moved to the Portals II, in southwest Washington. The new address is 445 12th St. SW, Washington, DC, 20554. The telephone and fax numbers will remain the same. Relocation of the commission offices and those of the General Counsel, Legislative and Intergovernmental Affairs, Mass Media Bureau and the Inspector General is complete. Other offices will move throughout March and April.

UTC Telecom launches two conferences

UTC Telecom '99 will launch two educational conferences at the annual meeting of UTC, The Telecommunications Association, this summer in Nashville, TN.

The Utility Telecom Business Development Conference will explore business opportunities for utilities offering carriers' carrier and consumer telecom services. The Utility Telecom & Information Technology Conference will focus on the unique aspects of managing utilities' telecommunications systems and information technology networks.

UTC president Bill Moroney said, "We launched these two conferences because as our member companies have expanded the array of telecommunications services they are offering consumers and businesses, we needed to find a new way to meet both their new and traditional education needs."

The two conferences will now be a part of UTC Telecom, to be held June 27–30, 1999, at the Opryland Hotel Conference Center. The trade shows will also include the UTC Expo; education workshops covering year 2000 contingency and radio spectrum management; and three pre-conference tutorials.

Harris restructures Communications sector

Harris, Melbourne, FL, is restructuring and renaming its business units within the Communications sector to leverage core competencies across the businesses that it hopes will result in increased customer satisfaction and improved operational effectiveness.

Harris is combining three of its former divisions, Digital Telephone Systems, Network Support Systems and Telecommunications Systems & Services into a single division called the Communications Products Division.

Van Cullens, president of Harris' Communications sector, said, "These three divisions are focused on the same customer base—the public and private communications service provider. By combining their strengths, we can more effectively address the market with a common focus."

The names of the Farinon and Broadcast divisions will change to more closely describe the markets they address. The Farinon Division will be known as the Microwave Communications Division. The Broadcast Division will be known as the Broadcast Systems Division. The RF Communications Division remains the same—providing RF products and services for the defense, air traffic control communications and national law enforcement markets.

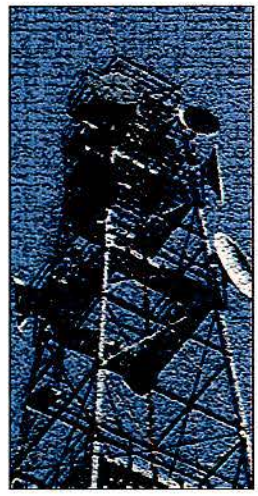
Clear, RSI form alliance to assist customers

Clear Communications Group, Atlanta, and Radiofrequency Safety International (RSI), Kiowa, KS, have formed an alliance. Clear is now a certified field service consultant for RSI. The purpose of RSI's field service consultants is to assist RSI customers with the technical aspects required to bring their telecommunications installations into compliance with the FCC's OET Bulletin 65 regarding RF emissions safety. Clear is developing and implementing a complete safety and exposure-testing program. The Clear/RSI alliance will offer consulting services to both Clear and RSI clients. As part of the alliance, RSI will provide safety and other programs to Clear's client base.

RSI also forged an alliance with Chase Systems of New Jersey. Chase represents the Wandel & Goltermann line of RF measurement equipment. RSI field service consultants will conduct RF surveys with either the EMR-300-meter or the new model 25 series FCC shaped probe, developed by Clear and RSI.

Triton PCS contracts American Tower

American Tower, Boston, and Triton PCS have entered into a contract where American Tower will build 115 build-to-suit tower development sites in North Carolina, South Carolina and Georgia. These sites will complement American Tower's existing tower portfolio. Triton PCS has also contracted American Tower's acquisition and zoning services for 175 sites in the same area. These sites will be completed as part of Triton's 1999 Phase II build-out.



Triton PCS's network covers 13 million people. Based in Malvern, PA, the company is a member of the AT&T Digital Wireless Network, which is licensed to cover more than 80% of the United States.

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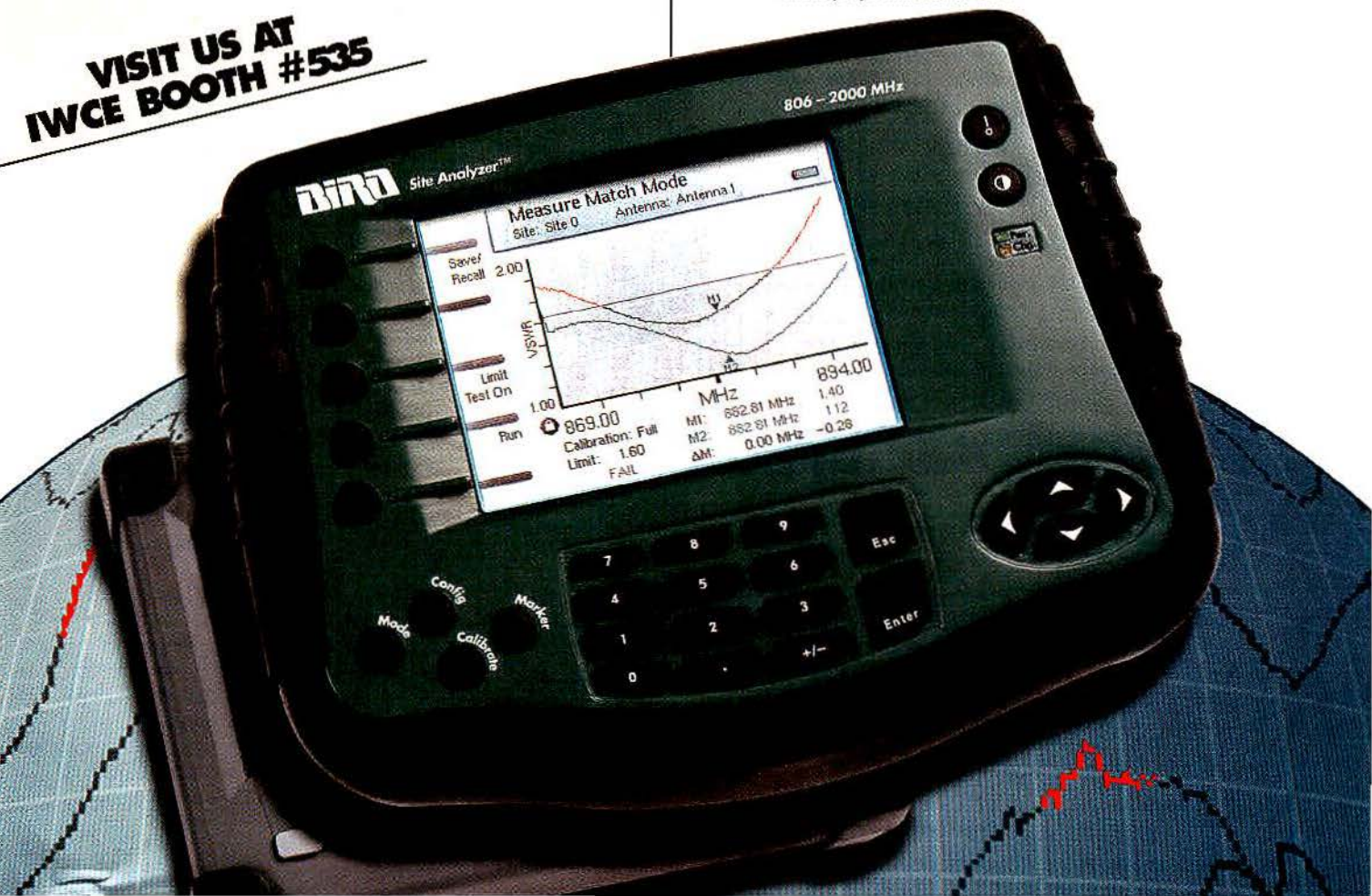


News Notes


Kloeckl

Cenex Harvest States has agreed to equip its transportation fleet with **Eaton Fleet Advisor**'s Transportation Logistics Management System.

Kit Kloeckl of Cenex Harvest States said, "Fleet Advisor's unique blend of full-function, on-board computing, cost-effective satellite communications and back-office networking will help us reach our efficiency goals by giving us the ability to significantly reduce administrative paperwork and increase driver and vehicle productivity."

MDSI, Mobile Data Solutions, of Richmond, British Columbia, Canada, signed a contract for the deployment of its Advantex-Utility mobile workforce management product to **New Jersey Natural Gas** (NJNG), the principal subsidiary of New Jersey Resources. MDSI also signed a contract with **Southern Connecticut Gas** (SCG), the principal subsidiary of Connecticut Energy to upgrade its existing MDSI system to take advantage of the latest innovations in technology. The combined value of the two contracts is about $1.6 million.

Jim Hallock, manager of customer dispatch, NJNG said, "The need for a radical overhaul of our first-generation system was critical in order to create a path for the future. With MDSI Advantex-Utility, NJNG has an open, flexible, supportable enterprise-wide solution that will allow us to respond over the long-term to a constantly evolving business environment."


Singer

Celwave's Andrew Singer received the CDMA Technology Conference's RCR Silver Award for his paper "Optimizing CDMA Antenna Systems." Singer is director of technical marketing for Celwave. The award was based on voting by attendees at the conference.

C&D Technologies and **Johnson Controls** signed a definitive agreement for C&D to acquire the business and assets of the **Industrial Battery** business of Johnson Controls for $135 million in cash and the assumption of certain liabilities.

Alfred Weber, chairman of C&D Technologies said, "This strategic acquisition strengthens and broadens our existing business in the growing UPS and telecommunications markets, while positioning C&D as an important participant in international markets and adding to our international presence."

In-Touch II from **In-Touch Management Systems** has been successfully installed in 17 markets, nationwide, for **TSR Wireless.** Some locations include Phoenix, Indianapolis, St. Louis and Minneapolis.


Volfing

Erik Volfing, vice president of finance at TSR Wireless, who supervised the conversion effort said, "Considering the magnitude of the job and the aggressive schedule set forth, the successful conversion from PBMS to In-Touch II has been quite an accomplishment for both TSR Wireless and In-Touch."

Yacht teams from seven nations competed for the Pacific Region's yachting prize, the Kenwood Cup, in a 547.5-mile, internationally recognized 10-race series.

Tom Wineland, president of **Kenwood Communications** said, "Sponsorship of the Kenwood Cup supports a well-known, high-quality, international sporting event. It is also a relaxed venue to hold high-level product planning meetings with the participation from a part of the Kenwood team we rely on quite extensively, the Kenwood dealers."

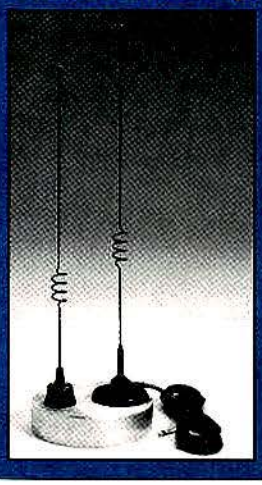
Mobile antennas

Vertical antennas provide wideband coverage

Maxrad's low-profile, vertical antenna provides wideband performance for most mobile or base station applications. The antenna series consists of two models capable of covering frequencies from 806MHz to 960MHz and 1,700MHz to 2,500MHz with good pattern coverage. These antennas will reduce overall inventory requirements. The compact design makes the antennas suitable for mobile or base station applications requiring minimum visibility. A ¾" hole-mount mechanism makes installation into an existing mount and replacement of existing antennas easier and economical.

Circle (351) on Fast Fact Card

Larsen develops disguised antennas



Larsen's cellular-look-alike mobile disguise antennas are available in the standard NMO configuration or a complete compact magnetic-mount version. The antenna design incorporates a heavy-duty 0.1"-diameter, black Kulrod copper-plated, open-coil whip for a cellular look. Each antenna is factory tuned and is available in either VHF or UHF frequencies. The diguise line is backed by a three-year warranty.

Circle (352) on Fast Fact Card

Redesign improves performance

Northpoint Communication Products' series of NMO mount-compatible LoPro antennas have gone through an engineering redesign to improve performance. The protective radome has a concentric ring pattern that makes the antenna smaller and flatter. More efficient dielectric material and reshaped radiators yield improvement in gain as well as overall performance.

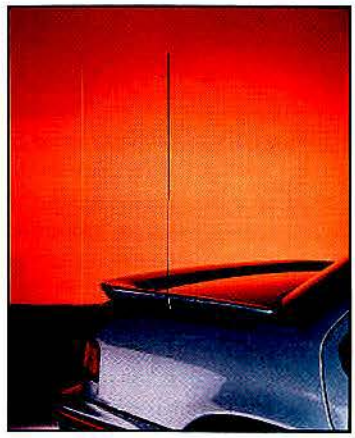
Circle (353) on Fast Fact Card

VHF antenna provides electric, magnetic field sensitivity

Antenex's VHF Phantom antenna is 3.5" high and has no whips. Gain is expressed in a new form: 3.5dB-MEG (mean effective gain). Following industry standards, the antenna mounts to a standard ¾" NMO mount. The antenna is sensitive to both electric and magnetic fields of signal. This unity gain is available in three frequency ranges: 144MHz–150MHz, 150MHz–156MHz and 156MHz–162MHz. Visit www.antenex.com for more information.

Circle (354) on Fast Fact Card

Dualband 150/800 antenna disguised as broadcast antenna



Sti-Co Industries' dualband 150/800 disguised mobile antenna operates on VHF and cellular or VHF and trunking frequencies. The dualband antenna system requires no field tuning, and the stainless steel AM/FM replica eliminates the need for additional antennas. The antenna can be used for surveillance, undercover or marked police vehicles, EMS and public safety vehicles, and private industry security vehicles. The company also has expanded its capability to include custom engineered antennas for specialized field applications.

Circle (355) on Fast Fact Card

Encoder supports digital paging formats

Wavetek's model 350 service encoder is a paging test system for Flex (two- and four-level FSK), POCSAG and Golay digital paging formats, as well as analog formats. The encoder generates mobile radio and paging system protocols. Pagers can be tested for selectivity and sensitivity. Verifying cap codes and recrystallizing pagers are easier. A serial computer port and flash memory are standard on the encoder and, with a user's PC, allow software updates without removing the unit's cover. The encoder can be operated directly, using front-panel controls, or remotely, using Pagershop software.

Circle (401) on Fast Fact Card

READERS' CHOICE

Of the new products in the July 1998 issue, this one generated the biggest reader response. For more information on this product, circle the corresponding Fast Fact number on the card found in the back of this issue, and mail the card to us.

Portable radio serves public safety

The Racal 25 portable radio from **Racal Communications** is used for government and public safety communications. The radio meets the Project 25 digital radio standard and also offers analog modes compatible with existing conventional radio systems. The radio is small and light, measuring 20.5 cubic inches and weighing 16.4 ounces. The size and weight is reduced by including digital technology developed for Racal's military customers. The rugged die-cast metal housing surpasses typical military specifications for rain test and is submersible in six feet of water. The radio is based on a digital signal processor design that allows advanced features and user-defined controls to be customized in software. The features include 256 channels with independently programmable CTCSS, CDCSS, Project 25 talk group, NAC and unit ID.

Circle (500) on Fast Fact Card

UHF antenna offers wide bandwidth

Maxrad's wideband chrome coil antenna series model MUF4002S covers UHF frequencies from 406MHz to 512MHz, with a 2dB gain capability and stable performance. The bandwidth is 106MHz and can be used without a ground plane, providing unity gain. The antenna features a low-profile design and stainless steel spring that make it durable and resistant to rough environments. It is easy to mount on a wide variety of vehicle locations. Several standard mount options can be used and are available with this antenna depending on installation requirements

Circle (402) on Fast Fact Card

Tester supports W-CDMA, IS-95 formats

Anritsu's MS8607A digital mobile radio transmitter tester measures the performance of W-CDMA and IS-95 devices quickly and accurately. Covering the 300kHz to 3GHz frequency range, the tester combines four instruments and offers modulation analysis and code-domain power measurement functions, making it suitable for research and development and manufacturing of mobile communication base stations and mobile units. The tester can make measurements in less than two seconds, and it can integrate a spectrum analyzer with a frequency range of 10MHz to 3GHZ, a transmitter tester, a thermocoupler power meter level range of 0dBm to 40dBm, and analog measurement functions for TACS, J-TACS and AMPS in one unit.

Circle (403) on Fast Fact Card

Tower-mounted amplifier improves talk-back

Celwave's trunking/SMR tower-mounted amplifier (TMA) 490105 allows for significant uplink range extension for rural sites. The TMA is a compact, weatherproof enclosure housing a low-noise amplifier (LNA) with preselector and impulse suppressor. The unit, which includes a current meter that monitors LNA performance, operates from 12Vdc to 20Vdc, negative ground. Portable talk-back range is improved by the TMA's low system noise figure (typically 1.8dB). The new unit used dual GaAsFET devices in hybrid configuration for high reliability.

Circle (404) on Fast Fact Card

Not even Bond has it this good.

Seneca System

Voice, data, GPS and images.

The Seneca™ Secure Mobile Radio Control System represents a new generation in law enforcement communications. It works with multiple wireless transceivers to provide mobile agents with an unprecedented range of secure connectivity.

This powerful system is capable of everything from remote database access and imagery transmission to fingerprint identification and position tracking. The Seneca System meets APCO Project 25 standards, supporting all of these functions with both wideband and narrowband communications, ensuring the highest levels of security.

Harris is continually exploring ways to improve and expand the field of secure mobile communications. The Seneca System puts all the data you need right at your fingertips.

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Battery protects multiple radios

The 20A Startguard (model NS-12-20) by **Newmar** protects the electronic memory of multiple mobile electronic devices from engine-start-related voltage drop. The battery helps public safety, emergency and fleet vehicles avoid interruption of data transmit and reprogramming of voice and data transceivers that crash during engine start. This typically occurs when the heavy current draw of engine start causes an abrupt voltage drop in the battery system, wiping out the vulnerable microprocessor memory. The battery automatically energizes when the starter motor is engaged, switching an internal battery on-line and providing critical power to the sensitive electronics—a full 20A for as long as 60 seconds. When the engine is running, the battery automatically recharges from the vehicle's alternator and is readied for the next start sequence.

Circle (405) on Fast Fact Card

Connector fits LMR-600 cable

RF Industries' N series coaxial connector is designed for use with LMR-600 low-loss cable from Times Microwave. The RFN-1002-2L2 is an N-male solder clamp connector aiding ease of assembly. All N series connectors for LMR-600 cable feature silver-plated bodies, gold-plated contacts and Teflon insulation. Silver plating minimizes intermodulation distortion. A broad range of other connector interfaces and styles is available for other LMR series coaxial cables.

Circle (406) on Fast Fact Card

Advanced keypad offers RF shielding

Dinet is installing advanced keypads in all of its mobile data terminals. This keypad not only provide tactility but also offers improved RF shielding. Testing of this keypad has shown no failures in 16 million pushes. Dinet has also introduced a substantial universal mount that will eliminate most of the vibration experienced in a mobile environment.

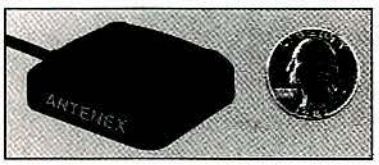
Circle (407) on Fast Fact Card

Ear set works in high-noise environments

Using "Talk-thru-your-ears" technology, the **CavCom 2000** brings together two-way radio communication with consistent hearing protection in a lightweight ear set and control box. Transducers, embedded in custom hearing protectors, transmit and receive voice commands through air conduction. The ear set can be used for applications such as fire and police departments, tactical operations, SCBA applications, and it can be used in high-noise industrial environments. The ear set is also safe for use in petroleum, chemical and other hazardous environments.

Circle (408) on Fast Fact Card

GPS antennas offer various mounts



Antenex's line of GPS antennas range from the micro GPS unit to the marine mount. The antennas are available in a variety of mounts. The micro GPS antenna is available in a magnetic mount. The utility GPS antennas are available with a magnetic or self-adhesive base. Features include 27dB gain, isolation from cellular channels at –24dB and active ceramic construction.

Circle (409) on Fast Fact Card

Digital E9-1-1 system serves call-taking, dispatch centers

Motorola's Commercial, Government and Industrial Solutions sector has developed several new features and capabilities as well as a new name for its line of digital systems serving E9-1-1call-taking and dispatch centers. The newly named Centralink 2000 E9-1-1 system (formerly called Centralink/Palladium 9-1-1 system) gives emergency call-takers the ability to handle, on a single screen, several functions that previously required separate screens or equipment. With on-screen call handling, the call-taker can use the computer keyboard function keys, a mouse click or the phone to answer calls, make automatic call-backs, use speed-dialing, check on the status of calls and handle at transmission from a telephone device for the deaf (TDD). The Centralink 2000 system is based on a Microsoft Windows NT platform. The system displays emergency call-taking and Motorola Centracom Gold Series radio dispatch functions on a single screen and combines system components on a local area network (LAN).

Circle (410) on Fast Fact Card

Suppressors protect base stations

Citel's new T1 line surge suppressor protects wireless base stations against lightning surges and electrical transients. Citel B280 and B480 use a heavy-duty multistage design. The small suppressors can be mounted inside a cabinet or on a backboard. They are available for one or two T1 circuits, and input/output connections are made with screw terminals or RJ45 jacks.

Circle (411) on Fast Fact Card

Converter offers vibration resistance

The **ICT** 10A, wide-range industrial power converter (model #ICT-4812-10A) is designed with a wide input voltage range of 20Vdc–65Vdc and an output of 12Vdc. It is built for harsh industrial environments and features vibration and moisture resistance, no internal wiring to shake loose, easy-access mounting holes, a terminal block connector, current limiting and over-voltage protection. The ICT wide range industrial power series are available in 10A and 20A models.

Circle (412) on Fast Fact Card

Portable offers trunked, conventional operation

The Patriot RTX Plus portable radio from **Ritron** features new firmware and a new electronics package. The radio is synthesized and programmable up to 5W and 11 channels and modes. It features the Passport trunking protocol and electronic serial number. The portable also offers wideband operation at 20MHz VHF and 30MHz UHF, multimode wide and narrow bandwidth switching on a per-channel basis and a built-in QC/DQC/DTMF encoder. It offers scan, battery status alert tones and adjustable battery saver timing. Surface-mount technology provides an electronics design that is strong and durable. A unique radio ID code and protocol provide automatic roaming between cooperating interconnected systems.

Circle (413) on Fast Fact Card

Communications receiver decodes trunked systems

Optoelectronics' Optocom PC-controlled communications receiver can decode and follow both Motorola and LTR trunked systems on any frequency band, including 400MHz, 500MHz, 800MHz and 900MHz. The receiver can also follow both trunked systems and conventional frequencies simultaneously. The receiver also decodes CTCSS, DCS and DTMF. It is a high-speed, triple-conversion receiver that scans at speeds as high as 100 channels per second because of pipeline tuning. It provides a store-and-scan feature, which allows the user to download as many as 28 frequencies or one talk group ID into the internal memory for scanning away from the computer, a suitable way to track one talk group ID in mobile applications. The Optocom also has a built-in data slicer circuit for decoding of FSK programs such as ACAS and WeFax, using third-party software. Other features include a CI-5 port for reaction tuning by the Scout frequency recorder, squelch and volume controlled by software and hardware, and a dedicated decoder plug-in buss for future third-party applications.

Circle (414) on Fast Fact Card

Mobile docking stations offer internal port replication

The Noteport line of mobile docking stations from **Gamber-Johnson** consists of three models that fit the Panasonic CF-25, Fujitsu 1000 and 1200 and the IBM Thinkpad. The stations provide internal port replication, full-featured internal power supply (including surge protection), an easily expanded and upgraded design, rugged construction and full-motion mounting and capability.

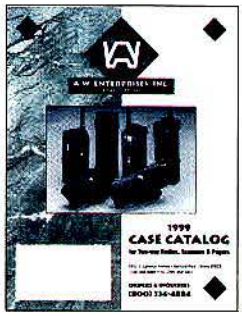
Circle (415) on Fast Fact Card

Full-duplex radiotelephone offers phone, fax, modem service

SmarTrunk Systems' ST-830 Smartphone full-duplex radiotelephone is for phone, fax and modem service for both mobile and fixed subscribers. Available in frequency bands from 130MHz to 520MHz, the radiotelephone can cover a wide range of wireless applications below 800MHz. Created for operation in a SmarTrunk II system, the phone is a 25W, full-duplex mobile transceiver with a built-in ST-869 Smartrunk II telephone interface module. The phone can provide mobile and fixed service identical to a "POTS" telephone line. While operation is normally full duplex, users are given the option to switch to a half-duplex configuration when placing mobile-to-mobile calls, minimizing channel use.

Circle (416) on Fast Fact Card

Catalog features radio cases



A.W. Enterprises' 1999 catalog of cases for the two-way radio marketplace contains cases for 200 radios, telephones, pagers and scanners, as well as case accessories. The cases fit radios supplied by most major radio manufacturers. The cases are made in a choice of hard leather, soft leather or nylon. The catalog also includes several changes for the last edition as well as new radio cases.

Circle (451) on Fast Fact Card

Booklet discusses available synchronization sources

Larus's fifth edition of its *Digital Network Timing and Synchronization* booklet discusses synchronization sources available to provide timing reference for digital network connectivity. This latest edition takes into account recent standards and new technology. It also discusses the hierarchical clocking scheme and its applications within public and private networks. The 38-page tutorial is divided into 13 chapters. The booklet is complete with functional timing system diagrams and a table listing clock strata requirements.

Circle (452) on Fast Fact Card

Web discussion board aids trunking professionals

The Genesis Group has opened "The Dove," a Web discussion board for trunking professionals. The board is a public service available to all trunking professionals at no charge. It is a resource for all trunking professionals to engage in industry specific discussions and problem solving. Since its inception, the board has been accessed 22,000 times and 150 messages have been posted. Specialized conference topics include general operations, buy/sell, end-user issues, employment, technical issues and usability topics. The site can be found at www.genesisworld.com/dovegateway.htm.

Circle (453) on Fast Fact Card

Manufacturer creates Web site

Aerotron-Repco Systems, has created a Web site for communications professionals. It allows users to access information on a wide range of data and voice communications products, including specifications and new product information. Complete specification sheets are available for downloading, and the site provides email access to all departments. www.aerotron-repco.com.

Circle (454) on Fast Fact Card

people


Barnes


Zoufonoun


Carey


Champagne

Promotions at Glenayre Western Multiplex, Sunnyvale, CA:

Graham Barnes, vice president of marketing, moves up to senior vice president of sales and marketing. **Amir Zoufonoun**, vice president of engineering, advances to general manager of the Glenayre Western Multiplex operating division, Charlotte, NC.

Raymond D. Ardizzone, chairman of Glenayre Technologies, Charlotte, NC, also becomes CEO and president.

Thomas J. Carey leaves Hewlett Packard, Palo Alto, CA, to become director of marketing for Anritsu's microwave measurement division, Morgan Hill, CA.

John D. Champagne, regional director of sales and marketing for World Access' Switching Systems and Services Group, advances to vice president of sales and marketing for Alpharetta, GA–based World Access' Wireless Infrastructure Group.

Seymour Krevsky receives the Gunther Award for his advances in high-frequency ionospheric radio propagation theory and techniques at the Radio Club of America annual dinner in New York.

Carmine Caferra leaves Electromagnetic Technologies, Springfield, NJ, as sales and marketing manager to become eastern regional sales manager for Berkeley Varitronics Systems, Metuchen, NJ.

Changes at the nationwide association of Motorola service station dealers (USMSS), Arlington, VA:

Ronald H. Runyan, vice president of Canyon State Communications, Pheonix, is elected chairman of USMSS. **George E. Fleming**, president of Chicago Communications Service, Elmhurst, IL, is elected as vice chairman of USMSS.

Robert Shuman, vice president of product management for Metawave Communications, Redmond, WA, advances to vice president, customer operations.

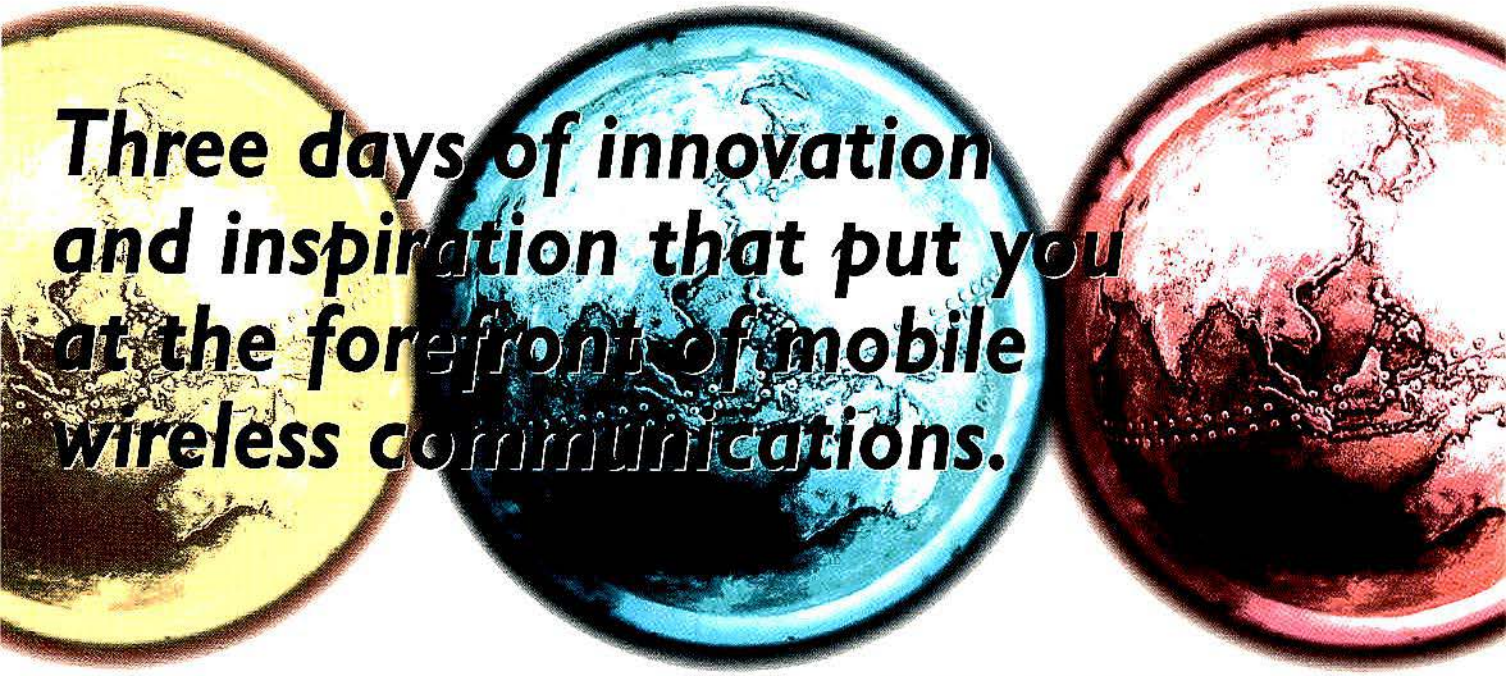
Richard J. Barber retires as executive director of the Pacific Telecommunications Council, which he helped found in 1980.

Louise P. Tucker leaves the Greater Washington Board of Trade, Washington, as director of the International Business Council to become vice president for communications and association services at the American Mobile Telecommunications Association, Washington.

Ann Cairns, national accounts executive for the National Dispatch Center, San Diego, moves up to manager, national accounts.

Changes at Powertel, West Point, GA:

Tim Knight leaves TechForce in Clearwater, FL, as corporate controller to become vice president–controller at Powertel. **Ann M. Milligan,** senior vice president of marketing for SCANA, Columbia, SC, is elected to the Powertel board of directors.



Three days of innovation and inspiration that put you at the forefront of mobile wireless communications.

The communications industry changes by the minute and competition is fierce. Emerging new markets are everywhere and what you don't know can hurt you. In 1999, knowledge is more than power; it's critical to your survival. The International Wireless Communications Expo (IWCE) leads you into the future of mobile wireless communications.

For 23 years, IWCE has been the industry source for the latest technology, insights and product introductions for the mobile communications industry. In April 1999, more than 10,000 industry professionals will gather with more than 350 exhibitors to shape the future of mobile communications. Make sure you're there.

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WHO SHOULD ATTEND:

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- resellers
- operators—community repeater operators, conventional RCC and private and cellular WCC base station operators
- commercial end users
- community repeater operators
- two-way, SMR, paging cellular and PCS base station operators
- engineering/consulting firms
- mobile communications managers for: public safety agencies, industrial plants, national/state/local government, military agencies, transportation companies, petroleum/energy companies and public utilities

YOU'LL SEE CUTTING-EDGE INNOVATION IN:

- paging
- private and cellular WCC base stations
- RCC
- PCS base station operators
- community repeater operators
- two-way mobile radio
- SMR

IWCE International Wireless Communications Expo

For conference updates as they develop, call FAX-ON-DEMAND at 1-800-601-3858 or +1-732-885-6723.

Make your Las Vegas Hilton reservations today!

HOUSING

The Las Vegas Hilton is the official hotel for IWCE '99. Hotel reservations at $98 per night can be made by calling 1-800-732-7117 or +1-702-732-5301. You may fax your request to +1-702-732-5805. Please include arrival/departure dates, housing needs and credit card number with expiration date for confirmation. Be sure to mention you're with IWCE '99.

CAR RENTAL

Call 1-800-331-1600 or +1-918-624-4298 and mention your Avis Worldwide Discount number D-188901 to receive your discounted meeting rate for IWCE '99.

AIRFARE DISCOUNTS

- **United Airlines** is offering a 10% discount off unrestricted mid-week coach fare or a 5% discount off the lowest applicable fare for domestic travel to IWCE attendees. An additional 5% is available on tickets purchased at least 60 days in advance. These discounted fares are available through United's Meeting Desk at 1-800-521-4041. Simply reference meeting ID Code 543QW to receive your discount. (Valid only on travel to/from the U.S., Canada and San Juan Puerto Rico.)

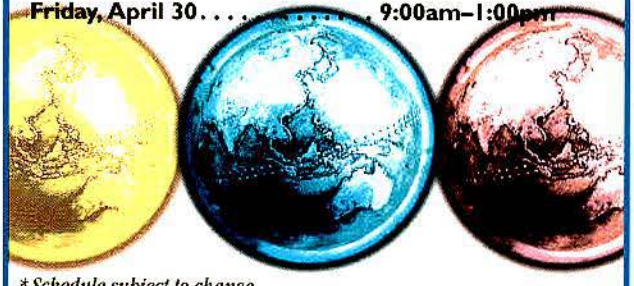
- **Delta Airlines** is offering a 10% discount on domestic flights for travel to IWCE, based on the published unrestricted round-trip coach rates. If you purchase your ticket at least 60 days prior to your departure date, you can receive an additional 5% bonus discount. Call Delta at 1-800-241-6760 or have your travel agent call Delta's toll-free number. Reference Delta Discount #125324A. Discounts do not apply to Delta Express.

EXHIBIT HALL HOURS*

Wednesday, April 28 . . . . . **10:00am–5:00pm**

Thursday, April 29 . . . . . **10:00am–5:00pm**

Friday, April 30 . . . . . **9:00am–1:00pm**



**Schedule subject to change.*

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IWCE 1999 CONFERENCE PROGRAM

Specialized education gives you the knowledge you need to do your job better.

It's the conference that puts you out in front all year. IWCE's conference program brings you up-to-date on the very latest industry developments and provides new tips and ideas you can put to work right away.

B Business Track

Here's where you'll learn tips on all aspects of successfully managing a mobile radio business. Presentations and discussions cover financial and strategic planning, advertising and promotion, product mix, staffing, customer service and billing software.

R Regulatory Track

What's happening on the regulatory front affects your operation, your bottom line and inherently the entire way you do business. Being informed can put you miles ahead of the competition. This track helps you get there.

T Technology Track

As innovations continue to push the communications industry into the future, this track keeps you up-to-date with the changing industry.

WEDNESDAY, APRIL 28, 1999

WELCOME and STATE OF THE INDUSTRY REPORT:
Cash and Chaos Theory 101
Wednesday, April 28 · 9:00-9:30am

KEYNOTE ADDRESS: Market Trends in Private and Public Radio: New Business Opportunities for Radio Dealers
Wednesday, April 28 · 9:30-10:45am

B Business Track

Wireless Data Solutions for Vertical and Horizontal Markets
Wednesday, April 28 · 1:00–1:30pm

Mobile Data: The Truth Behind the Myths
Wednesday, April 28 · 1:30–2:00pm

Money-making Opportunities in Mobile Data
Wednesday, April 28 · 2:00–2:30pm

Utility System Opportunities for Mobile Radio
Wednesday, April 28 · 3:00–3:30pm

How Dealers Can Use the Internet to Increase Business
Wednesday, April 28 · 3:30–4:00pm

Development of a Regional Computer System for Public Safety Uses
Wednesday, April 28 · 4:00–4:30pm

Inventory Management: Getting the Most Out of What You've Got
Wednesday, April 28 · 4:30–5:00pm

R Regulatory Track

Auctions and Licensing: An Update
Wednesday, April 28 · 1:00–1:30pm

800 MHz Incumbent Operator Rights: What Now?
Wednesday, April 28 · 1:30–2:00pm

How FCC Rules are Made
Wednesday, April 28 · 2:00–2:30pm

Technology Track

How to Migrate from Analog to Digital Cost-effectively
Wednesday, April 28 · 1:00–1:30pm

DSP Applied to Conventional and Trunking Voting/Comparator Systems
Wednesday, April 28 · 1:30–2:00pm

The Cellular Multi-carrier Amplifier Revolution: Will Two-way Radio Follow Suit?
Wednesday, April 28 · 2:00–2:30pm

Industry Leaders Meet the Press
Wednesday, April 28 · 3:00–5:00pm

Moderated by Jerry Whitaker

From the Press:
David Keckler, *Mobile Radio Technology*
Monica Alleven, *Wireless Week*
Tina Eichner, *RCR*
Stacy Skillern Horne, *Radio Resource*

Industry Leaders:
Don Vasek, PCIA
Alan Shark, AMTA
Paul Najarian, ITS
Mark Crosby, ITA
Joe Hanna, APCO

THURSDAY, APRIL 29, 1999

Business Track

Getting to Know Your Customers and Their Requirements
Thursday, April 29 · 9:00–9:30am

Training and Continuing Education: A Critical Requirement for Business Success
Thursday, April 29 · 9:30–10:00am

Specialty Wireless Applications in the Mobile Industry
Thursday, April 29 · 10:00–10:30am

BUSINESS ROUNDTABLE
New Business Opportunities for Small Mobile Operators
Thursday, April 29 · 11:00–12:30am

Interconnection for Carriers: Termination Compensation and Facilities Charges
Thursday, April 29 · 3:30–5:00pm

Regulatory Track

Approval Regulations for Radio Communication in Europe
Thursday, April 29 · 9:00–9:30am

International Mobile Business: Challenges and Opportunities
Thursday, April 29 · 9:30–10:00am

Strategy in Israel for the Future: Mobile and Personal Communications
Thursday, April 29 · 10:00–10:30am

REGULATORY ROUNDTABLE: New Business Opportunities for Paging Operators
Thursday, April 29 · 11:00–12:30am

Planning a UHF Trunking System: Opportunities and Pitfalls
Thursday, April 29 · 3:30–5:00pm

Technology Track

Single Point or Multi-point Grounds: A Comparison
Thursday, April 29 · 9:00am–10:15am

Specifying Solar Photovoltaic Power for Wireless Applications
Thursday, April 29 · 9:30–10:00am

New Antenna Technologies for Portable Applications
Thursday, April 29 · 10:00–10:30am

TECHNOLOGY ROUNDTABLE
Planning a Wide Area Dispatch Only Network: What You Need to Know
Thursday, April 29 · 11:00–12:30am

Test Equipment Workshop: What to Measure and How to Measure It
Thursday, April 29 · 3:30–5:00pm

FCC Roundtable Forum
Thursday, April 29 · 1:30–3:00pm

In this session, attendees will hear the latest on FCC activities, and have the opportunity to question FCC staff members on important industry topics. **Scheduled to attend from the Commission:** W. Riley Hollingsworth, Ira Keltz, Kathryn Garland, Richard Lee, Steve Miller, Roger Noel. **Moderator:** Don Bishop

FRIDAY, APRIL 30, 1999

Business Track

Wireless Telemetry: What's in it For You?
Friday, April 30 · 9:00–9:30am

The Future Business Potential for Smart Mobile Devices
Friday, April 30 · 9:30–10:00am

Wireless Data Communications: The Time is Now
Friday, April 30 · 10:00–10:30am

Technology Trends in the Wireless Industry
Friday, April 30 · 10:30–11:00am

Regulatory Track

The Regulatory Landscape: What to Watch Out For
Friday, April 30 · 9:00–9:30am

RFR Requirements and Liabilities
Friday, April 30 · 9:30–10:00am

Human Exposure to RF Radiation: Dealing with the Issue
Friday, April 30 · 10:30–11:10am

Evaluating Your Tower Site
Friday, April 30 · 10:30–11:10am

Technology Track

High-Speed Wireless Interconnect for IP Networks
Friday, April 30 · 9:00–9:30am

Application Aware Networking: Addressing Your Infrastructure Needs
Friday, April 30 · 9:30–10:00am

DSP: The Key to Software Radio Technology
Friday, April 30 · 10:00–10:30am

Tuesday, April 27 · 9:00am–5:00pm

PCIA's Licensing Skills and Part 90 Educational Workshop

Make the most of today's technology by understanding the new FCC Form 601 scheduled for implementation in April 1999. The Personal Communications Industry Association (PCIA) hosts a pre-conference workshop that will provide attendees with comprehensive guidance through all the elements of Form 601, including how to file accurately and efficiently.

The information-packed seminar covers these timely topics:

- **Part 90 frequency license application and Form 601**
- **Acquiring and clearing spectrum for VHF/UHF trunking**
- **Getting rid of "Dead Wood" licenses**
- **Nuances of the new 150/450 MHz rules**
- **Carrier obligations**
- **800 MHz relocation and its future**

Conducted by PCIA staff, experienced in spectrum management responsibility for frequencies including low band, VHF, UHF, paging, 800/900 MHz business radio and 929 MHz paging in land mobile radio.

Course includes continental breakfast and exhibit hall pass.

Thursday, April 29 · 7:30–9:00am

RCA Breakfast Meeting

The Radio Club of America is holding a breakfast at the Las Vegas Convention Center, rooms N107-108. **Speaker:** Jay Kitchen, President, PCIA. **Co-sponsored by:** Remote Monitoring Services, Wireless Market Place, EF Johnson. Pre-registration is mandatory. For reservations, please call Michelle Knitter at +1-972-580-1911. Deadline: April 26, 1999.

RF DESIGN SEMINAR SERIES

In IWCE's effort to provide the best education in the industry, the RF Design Seminar Series provides technical sessions and tutorials for engineering professionals. As today's marketplace continues to be re-defined, so do the strategies needed to bring these products to market. The RF Design Seminar at IWCE provides educational workshops for radio frequency design engineers and managers. You can register for individual sessions or save big when you register for the entire seminar track. Includes IWCE exhibit hall pass and course materials.

Subsystem Design Track

(Instructional Level: Intermediate)

Practical Filter Design (S1)

Tuesday, April 27 · 8:00am–5:00pm

Covers all aspects of practical lumped element (L-C) and distributed (transmission line) filter design for applications from 1 MHz to 18 GHz. Emphasis is on the frequency range from 70 MHz through 5600 MHz for CATV, instrumentation and wireless systems such as mobile radios, cellular, PCS, satellite systems, WLAN and telemetry. Topics include components, loss, realizability, computer techniques, equivalent networks, conventional transforms, group delay, symmetry, coupled resonator, printed and machined filters. **Presenter:** Randy Rhea, Eagleware

Oscillator Design Principles (S2)

Wednesday, April 28 · 8:00am–5:00pm

Learn a unified approach to the design of oscillators with L-C, transmission line, SAW and crystal resonators. Oscillators are demystified. Design by modifying existing designs is replaced with a complete understanding which leads to higher performance and lower cost oscillators. Both VCO and high stability fixed oscillators are covered. Topics include starting, non-linear behavior, phase noise, harmonics, tuning, Q and low and high power. Principles apply to most oscillators but the 100 to 2400 MHz frequency range is emphasized. **Presenter:** Randy Rhea, Eagleware

Digital Applications Track

(Instructional Level: Intermediate to Advanced)

Frequency Synthesis and Phase Locked Loop (D1)

Tuesday, April 27 · 8:00am–5:00pm

A course designed to help engineers design state-of-the-art frequency synthesizers that are used in all modern communications equipment. The emphasis is on understanding the basics and how to model and analyze the operation of phase lock loops to meet specific performance requirements. Extensive use of circuit and mathematical modeling is used to model loop performance such as switching speed, modulation, phase noise and acquisition. Real world problems, including noise, spurious and shielding are presented. The various components that comprise a PLL including oscillators, dividers and phase detectors are discussed. There are examples of state-of-the-art commercial products. New techniques including DDS and fractional N are presented. The course concludes with a section on testing the PLL for verification of design parameters. **Presenter:** Eric Drucker, PLL Consultants

Digital Signal Processing

Part I (D2) ***Wednesday, April 28 · 8:00am–5:00pm***

Part II (D3) ***Thursday, April 29 · 8:00am–5:00pm***

This two-day course provides an introduction to Digital Signal Processing that is both understandable and comprehensive. Although the mathematical content of the course is low to moderate, the fundamental equations of DSP are gently introduced and carefully explained. With full sympathy for the DSP beginner, this course uses just enough mathematics to develop a fundamental understanding of DSP theory, and illustrates the theory with well-chosen examples. Low-pass and band-pass sampling, discrete fourier transform and finite impulse response filters are covered. **Presenter:** Richard Lyons, Besser & Associates

BASE STATION WORKSHOPS

After its well-received debut at IWCE '98, this series returns to IWCE as a vital part of the comprehensive programming for base station operators and technicians. Whether a beginner or veteran, the base station workshops offer solutions you can put to use right away. Industry experts predict that 100,000 base stations will be in operation within the next few years. A key aspect of the performance of these systems is training and educating the on-site support staff. This series of workshops form a comprehensive instructional program designed specifically for the needs of the base station technician and operator. Attendees may register for individual courses or save big when you register for the entire sequence. Includes IWCE exhibit hall pass and course materials.

Fundamentals of Radio Communications (W1)

Monday, April 26 · 8:00am–5:00pm

This course will focus on the basic elements of radio communications systems, as well as propagation and the base station operating environment. Upon completion of the course, the attendee will have been exposed to information describing the components and operation of the systems s/he maintains and the nature of operational performance problems that are typical in the communications industry. **Presenter:** Al Scott, Besser & Associates.

Testing the Base Station RF Subsystem (W2)

Tuesday, April 27 · 8:00am–5:00pm

The most important job of the base station technician is to ensure that the network is working properly from the standpoint of its RF components including receivers, transmitters, amplifiers, baseband subsystem, transmission line and antenna. This course will provide a thorough examination of the parameters that must be measured, the instruments available to measure signals and the methodology behind the measurement technique. Specific test equipment will be used to demonstrate the discussion which is

Technology Track

(Instructional Level: Technology Introduction)

RF and Wireless Made Simple (T1)

Tuesday, April 27 · 8:00am–5:00pm

This tutorial-level course is ideal for technical managers and marketing professionals who need to know about RF and wireless technologies without suffering through lengthy and complex mathematical explanations. This lively and informative course includes time devoted to RF principles, systems and devices. Discussion also includes highlights of wireless systems at a block diagram level. **Presenter:** Al Scott, Besser & Associates

Measuring the Wireless Transmission Spectrum (T2)

Wednesday, April 28 · 8:00am–5:00pm

Discover the power of the latest spectrum-based measurement and analysis techniques for the wireless spectrum. How do you catch, identify and eliminate impairments in your cell phone transmissions? How can you get optimum spectrum utilization efficiency for your pager system? What is the digital modulation spectrum about? Discover different measurements that are possible in the frequency domain, such as: spectral purity, occupied bandwidth, adjacent channel power leakage, spectral regrowth, interference, signal-to-noise-ratio... and much more. This course is presented by the recognized expert in the field, author of reference books on spectrum analysis and Fellow of IEEE for contributions to spectrum analysis. Bring your questions on spectrum analysis and you will leave with answers. **Presenter:** Morris Engelson, Joint Management Strategy

Antennas and Propagation for Wireless Communications (T3)

Thursday, April 29 · 8:00am–5:00pm

This tutorial/workshop provides a fundamental and broad introduction to antenna properties, antenna design considerations and RF propagation issues. It begins with basic concepts and definitions used in the antenna and propagation industry. Antenna characteristics such as VSWR, radiation pattern, polarization, axial ratio, directivity, gain and EIRP are defined and their impact on wireless system performance are illustrated. Also, an overview of different antenna types including wire antennas, portable, microstrip, circularly polarized and aperture antennas is presented, as well as the basic concepts associated with the design and performance of antenna arrays. RF propagation issues such as path loss, multipath fading, polarization distortion, noise and interference and diversity implementation are described and their impact on system performance is illustrated. An overview of the different types of antennas used in today's wireless communications systems is also presented. Plus some practical examples of the concepts presented and demonstrations of actual antenna design using some commercially available antenna design software. **Presenter:** Steven R. Best, Cushcraft

Engineering Track

(Instructional Level: Engineering Introduction)

Wireless Engineering

(CEU Credits Available)

This series is designed for engineers who have no previous experience or those who need to "brush-up" on their RF design skills. It's also useful for managers who need to become familiar with RF terms and concepts to better communicate with their design team.

Part I: Foundations of RF Hardware Design (E1)

How Wireless Systems Influence Hardware Requirements, RF Circuit Fundamentals, Components at RF Frequencies and Transmission Lines.

Tuesday, April 27 · 8:00am–5:00pm

Fundamental circuit concepts such as gain, bandwidth, noise figure, resonance, and Q are presented. The behavior of passive inductors, capacitors and resistors at RF frequencies is reviewed and methods of modeling them discussed. Transmission line theory is reviewed and principles of the Smith chart are presented. **Presenter:** Robert Feeney, Georgia Institute of Technology

Part II: Techniques for RF Hardware Design (E2)

Impedance Transformation Networks, Device Models and Design Using S-Parameters Fundamentals of Computer Analysis and Optimization.

Wednesday, April 28 · 8:00am–5:00pm

Both graphical (Smith chart) and analytical methods are presented to show systematic procedures and techniques applicable at RF and microwave frequencies. Example networks are designed and discussed. Active device models are discussed and the theory and use of S-parameters for RF is presented. **Presenter:** Robert Feeney, Georgia Institute of Technology

Part III: Amplifier Design (E3)

Biasing, Stability, and Example Designs of Low-noise, Wide-band, Feedback and Power Amplifiers.

Thursday, April 29 · 8:00am–5:00pm

The third day uses the theory and techniques developed in the first two days to design RF, VHF, UHF6, and microwave amplifiers. Other practical topics such as out-of-band stability and bias network design are also discussed.**Presenter:** Robert Feeney, Georgia Institute of Technology

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applicable to a variety of manufacturer's equipment. The attendee will be exposed to the differences between measuring analog and digital systems, measurements specific to digital communication systems and measurements specific to TDMA and CDMA access methods. **Presenter:** TBA

Maintaining and Troubleshooting the Transmission Chain (W3)

Wednesday, April 28 · 1:00pm–5:00pm

It has been stated that 60 percent of the problems encountered in wireless base station operation are caused by transmission line, interconnects and antennas. These components are exposed to a harsh operational environment. This course will familiarize the attendee with the transmission of RF energy from the transmitter to the antenna. It will highlight the areas in which problems develop, how to spot them, remedial methods and tools available to verify the problem is resolved. **Presenter:** TBA

Maintaining Reliable Base Station Power (W4)

Thursday, April 29 · 8:00am–12:00pm

Maintaining reliable electrical power to the base station is an essential concern. This course will outline the types of electrical disturbances and their effect on the base station power supply, problems that can develop, tools available to spot them and measures that can be taken to prevent power quality events from disrupting operations. **Presenter:** Mark Nielsen, Northern Technologies

Understanding and Maintaining the Wired-to-Wireless Link (W5)

Friday, April 30 · 8:00am–5:00pm

Maintenance of a base station does not end with the RF system. The interface between the base station and the wired telephone network as well as the back haul link to the central station are equally important. This course provide an overview of these links, the parameters that must be monitored, problem areas, measurements and remedial measures. **Presenter:** Harry E. Young, Young Ideas Telecommunications Consulting

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American Tower Corp.
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ADVANCE REGISTRATION FORM

Please complete all questions. Photocopy for additional registrants. Incomplete forms cannot be processed. Photography is not allowed in exhibit hall. Must be 18 years of age to attend. You will receive written confirmation if you register by March 26, 1999.

IWCE — April 28-30, 1999
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② PROGRAM REGISTRATION

■ IWCE CONFERENCE AND EXHIBITS

		on or before 4/2/99	after 4/2/99*
C	❑ IWCE Conference and Exhibits	❑ $430	❑ $530
W	❑ Exhibits and Wednesday Conference	❑ $230	❑ $280
R	❑ Exhibits and Thursday Conference	❑ $230	❑ $280
F	❑ Exhibits and Friday Conference	❑ $230	❑ $280
E	❑ Exhibits Only (all three days)	❑ $ 40	❑ $ 50

IWCE Conference and Exhibits Registration Subtotal: $ _____

■ RF DESIGN SEMINARS *After 4/2/99 on a space available basis only*

Register for individual session, or save BIG when you register for an entire seminar track. Includes IWCE exhibit pass and course materials. ***To make your selections, cross-reference the codes below with the course descriptions found on Fax-On-Demand at 1-800-601-3858 or +1-732-885-6723.***

Tuesday, April 27 (check one) ❑ T1 ❑ E1 ❑ S1 ❑ D1
Wednesday, April 28 (check one) ❑ T2 ❑ E2 ❑ S2 ❑ D2*
Thursday, April 29 (check one) ❑ T3 ❑ E3 ❑ D3*

*Two-day course charge applies.

	on or before 4/2/99	after 4/2/99*
❑ One course/one day (as checked above)	❑ $340	❑ $440
❑ Two courses/two days (as checked above)	❑ $640	❑ $830
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Monday, April 26 ❑ W1 **Thursday, April 29** ❑ W4
Tuesday, April 27 ❑ W2 **Friday, April 30** ❑ W5
Wednesday, April 28 ❑ W3

	on or before 4/2/99	after 4/2/99*
All 5 Workshops	❑ $1090	❑ $1400
Full day courses (W1, W2, W5)	❑ $300 *each*	❑ $390 *each*
Half day courses (W3, W4)	❑ $170 *each*	❑ $220 *each*

Base Station Workshops Registration Subtotal: $ _____

■ SPECIAL EVENTS *After 4/2/99 on a space available basis only*

	PCIA members	Non-members
P ❑ PCIA Workshop (Tuesday, April 27)	❑ $230	❑ $280

Includes continental breakfast on Tuesday and exhibit hall pass for all three days.

TOTAL REGISTRATION FEES: $ _____

Badges will be mailed if registration form is received by March 26, 1999. Otherwise, please pick up your badge on site.
**After 4/2/99, please register on site.*

③ PROFILE *(all questions must be answered)*

1) WHAT IS YOUR JOB FUNCTION? (check only one)

A ❑ Corporate Mgmt.
B ❑ Communications Mgmt.
C ❑ Technical/Service Mgmt.
D ❑ Communications Mgmt.
E ❑ Sales/Marketing
F ❑ Design/Development Engineering
G ❑ Base Station Mgmt.
O ❑ Other_____

2) WHAT BEST DESCRIBES YOUR BUSINESS? (check only one)

End User
A ❑ Commercial User of Radio Communications Equipment
B ❑ Public Safety/ Government User
C ❑ Consulting/Engineering Firm

Service Provider
D ❑ Cellular Telephone System Operator
E ❑ PCS Telephone System Operator
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N ❑ Manufacturer's Rep
P ❑ Agent
Q ❑ Retailer
R ❑ Exporter/Importer
S ❑ Manufacturer

Other
T ❑ Association/Academia
U ❑ Press/Media*
O ❑ Other_____

3) WHAT ARE YOUR INTERESTS? (check ALL that apply)

A ❑ Two-way Radio
B ❑ Paging
C ❑ Cellular
D ❑ PCS
E ❑ Mobile Data
F ❑ RF Design/Components
G ❑ Base Station Equipment
H ❑ Systems Integration
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4) WHAT BEST DESCRIBES YOUR PURCHASING ROLE? (check only one)

A ❑ Make final decision to purchase product
B ❑ Recommend/specify products for purchase
C ❑ No purchasing role

**If registering as Press/Media, please send credentials with this form.*

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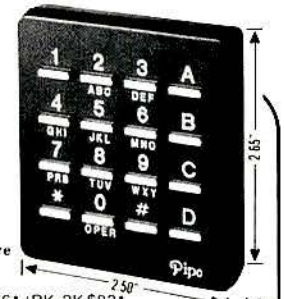

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Harris RF Communications Div.	53	47	716-242-3851
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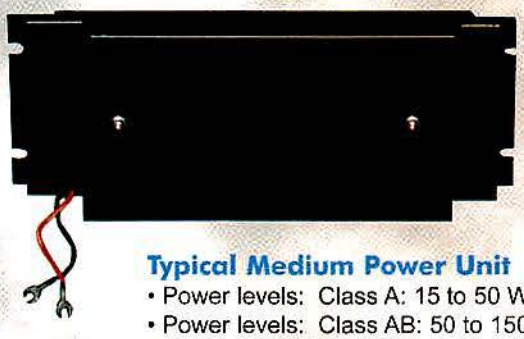
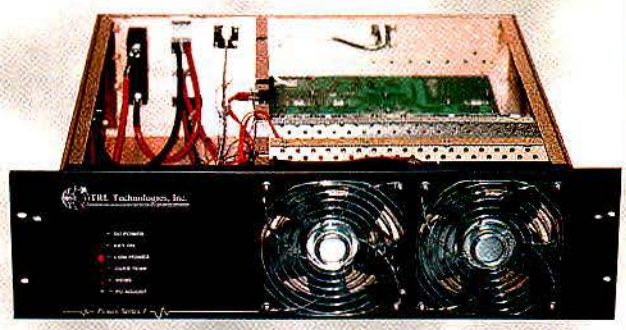
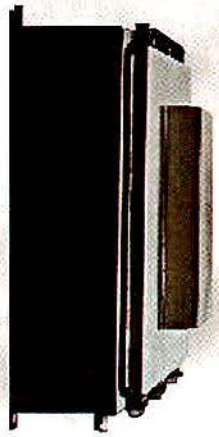


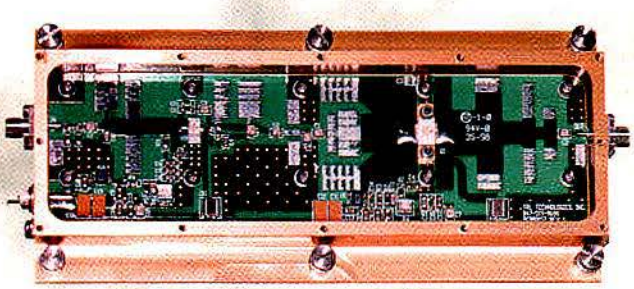
Typical Medium Power Unit
- Power levels: Class A: 15 to 50 Watts
- Power levels: Class AB: 50 to 150 Watts
- Size: 19" x 5.20" x 5.25"



Typical High Power Unit
- Power levels: Class A: 50 to 150 Watts
- Power levels: Class AB: 150 to 500 Watts
- Size: 19" x 5.20" x 16.5"



Typical Bi-Directional Amplifiers
- Cellular/DCS/PCS/Trunking
- Power levels: 10 to 100 Watts
- Size: 20" x 16" x 8"



Typical Class A Modular Unit
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- Power levels: Class AB: 10 to 100 Watts
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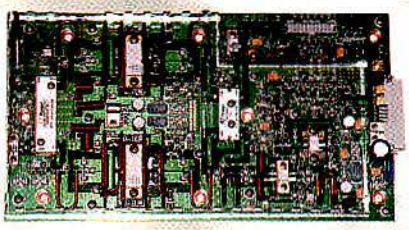

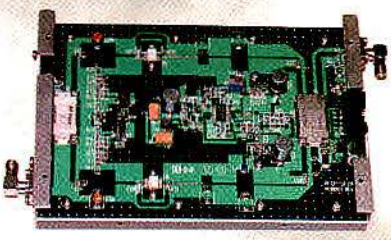

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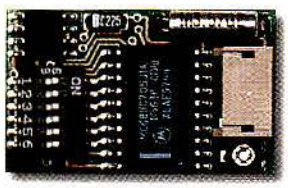

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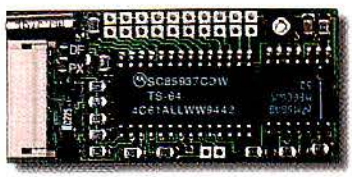

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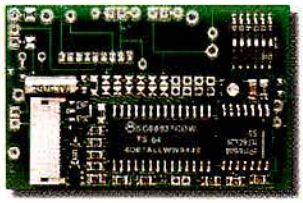

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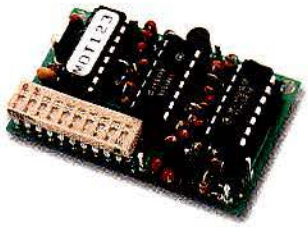

SD-1000 $59.95
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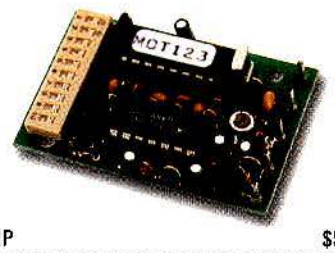

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1.25" x 2.0" x .4"

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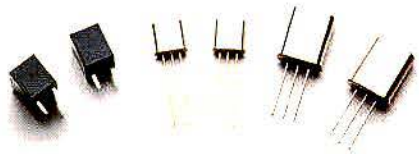

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